MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XXXVI SEPTEMBER–OCTOBER, 1944 No. 5

NEW OR HERETOFORE UNREPORTED SPECIES OF THE HIGHER ASCOMYCETES FROM COLOMBIA AND VENEZUELA[1]

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During the last two decades there has been an increasing interest in the knowledge of the mycological flora of South America, especially of countries like Colombia and Venezuela, which of large geographical extent and with a great diversity of climatic conditions, offer to the mycologists an almost unexhaustable field for exploration, especially in regard to the great number and variety of species. The mycological explorations in these two countries however, have been relatively few, the most important contributions being those of Chardon, Toro and Kern (**6**, **7**) to whom the author refers the reader for a more detailed account of the studies made on the subject in those countries.

The present paper is based largely on recent collections made by several persons, chiefly by Dr. Chardon and by the author in Colombia and by Drs. H. H. Whetzel, M. F. Barrus and A. S. Müller in Venezuela. These specimens are deposited in the Plant Pathology Herbarium of Cornell University, in separately numbered exsiccata sets, duplicates of the Colombian collections being kept at the herbarium of the Facultad de Agronomia, Medellín, and the herbarium of the Instituto de Ciencias Naturales, Bogotá, while

[1] Presented as a thesis for the master's degree at Cornell University. March 1944.

[MYCOLOGIA for July–August (**36**: 313–428) was issued August 1, 1944.]

duplicates of those from Venezuela are deposited at the "El Valle" Agric. Exp. Station, Caracas.

In order to avoid constant repetition the letters "FC" will be used for the fungi from Colombia, and "FV" for those from Venezuela, while the abreviations "Med." and "Bog." will be employed to designate the herbaria at Medellín and Bogotá, respectively; "FPR" will be used to designate specimens from the Fungi of Porto Rico in the Herbarium of the Department of Plant Pathology in Cornell University. The collections made by R. A. Toro in Colombia in 1927–28 and now in the herbarium of the Department of Plant Pathology at Cornell University are designated, "Toro FC," followed by his serial number. Specimens cited from the general collections of the same department will be designated "CUPP."

Fifty species are here reported; 38 from Colombia and 14 from Venezuela, two of them occurring in both countries. Sixteen are new species, the others being heretofore unreported or recorded for the first time on new hosts or from new localities.

The author wishes to acknowledge his deepest obligation to Professor H. H. Whetzel of the Department of Plant Pathology of Cornell, for his aid and encouragement in the work as well as for his suggestions and criticisms. Thanks are also due the Misses Ellen North and Stephanie M. Jakimowitz for their kind coöperation in the preparation of the latin diagnoses of the new species.

Order PERISPORIALES

Even though the number of species of the *Perisporiales* already reported in Colombia and Venezuela is rather small, this group of fungi, and specially some of its families appear to be very rich in number of species. This is to be expected on account of the tropical, humid conditions which favor the development of these forms. The *Erysiphaceae* on the other hand, many forms of which appear in the conidial stage, have rarely been found in the perfect stage. The order *Perisporiales* is considered here in the sense of Theissen and Sydow (**32**) but the *Meliolinae* have been studied on the basis of Stevens' monograph (**24**, **25**). The Beelian formulas of the new species here described have been established in accordance with the slight changes introduced by Stevens.

Family PERISPORIACEAE

PSEUDOPARODIELLA VERNONIAE Stevens, Illinois Biol. Monog. **11**^{2}: 14. 1927.

On *Vernonia canescens* HBK.

COLOMBIA, Antioquia, Highway Medellín-Rionegro, K 7, 1800 m., Garcés, Dec. 3, 1941. FC *1560*; Med. *273*.

VENEZUELA, Miranda, San Antonio de los altos, M. F. Barrus and A. S. Müller, Dec. 8, 1939. FV *3660*.

The specimens were compared with Stevens' type from Costa Rica. The Colombian and Venezuelan materials show a greater abundance of the conidial stage.

PARODIOPSIS STEVENSI Arnaud, Ann. Epiphy. **9**: 22. 1923. *Perisporium truncatum* Stevens, pro parte.

On *Inga* sp.

COLOMBIA, Tolima, near Campoalegre, 1200 m., G. Quintana, Apr. 15, 1941. FC *1320;* Bog. *903*.

This fungus first described from Porto Rico where it seems to be common on *Inga* sps., is very conspicuous on the under side of the leaves in the form of smoky, black patches sometimes covering a great portion of the blade. As it is very probable that its geographical range is wider than what is now known, it appears desirable to clear up some facts of its history. Fries (**10**) created the genus *Perisporium* including 16 species, 9 of which Saccardo (Syll. Fung. **1**: 58–60. 1882) considers as doubtful, the other 7 being excluded as synonyms, among them *Perisporium gramineum* which, due to the fact of its being the first described species, may be considered the type. Based on these considerations and on the fact that some of the species included by Saccardo under *Perisporium* prove to be Aspergillaceous, Theissen and Sydow (**32**: 448) dropped the genus from consideration. In the same year Stevens (**22**) described his *Perisporium truncatum* on *Inga laurina* (FPR *7049*) with "spores 2-septate, cylindric, 68–92 × 10 μ, hyaline when young, smoky or darker when old, rounded at one end, truncate and with a ring around the other end." Later on Arnaud (**2**) examined the material collected by Stevens and provisionally

erected (due to the absence of mature ascospores as stated in a foot-note) the species *Perisporina truncata* (Stevens) Arnaud, considering it as a synonym of *Perisporium truncatum* Stevens. Later Arnaud (**3**) studied the Porto Rican specimens collected by Whetzel and Olive (FPR *533* and *601*) and determined by Chardon as *Perisporium truncatum* Stevens, and also no. *7049* of Stevens' collection (the type). Another specimen from Chardon's own herbarium, *616,* was also studied. The four specimens were shown to be the same fungus, the first two mentioned being in a more advanced stage of maturity. The type specimen showed no ascospores. Chardon's *616* had some more mature perithecia with very few 1-septate spores resembling those found on FPR *533* and *601.* None of the specimens showed the ascospores as described for *Perisporium truncatum,* which according to Arnaud (loc. cit.) are very similar to those of *Perisporina manaosensis;* Arnaud concluded by suggesting the possibility that a *Parodiopsis* might occur on the same leaves.

In the material examined he could find no fully mature ascospores, although some of them were mature enough to show the septation of the spores. These ascospores never had more than 1 septum, being hyaline, constricted at the septum and very variable in length and width, averaging $50 \times 12\ \mu$. He subsequently erected the species *Parodiopsis Stevensi, pro parte.* In referring to *Perisporina truncata* (Stevens) Arnaud, Arnaud says: "The perithecia described by Stevens show by the character of the ascospores that they belong to a *Perisporina* but on the material sent we could only find the *Parodiopsis Stevensi,*" and concludes that there were on the leaves of Stevens' specimen a *Parodiopsis* and a *Perisporina* with similar vegetative characters.

The author examined Stevens' type, *7049* (duplicate in CUPP *1266*), and found that the ascospores, even the young ones, are 2 septate, all other characters being as described by Stevens. This fact establishes the validity of Arnaud's species *Perisporina truncata.* On the other hand an examination of the Porto Rican material (FPR *533, 601* and *602*) shows the presence of the hyaline 1-septate ascospores of *Parodiopsis Stevensi* Arnaud. This leads the author to the conclusion that *Parodiopsis Stevensi* is a separate species and not the immature stage of *Perisporina truncata,* as

might be thought from the fact that both species are essentially alike except for the septation of the ascospores.

The Colombian material does not present mature ascospores either, but they are hyaline, 1-septate and very much like those on specimens FPR *533* and *602*.

Parodiopsis bicoronata sp. nov.

Colonies epiphyllous blackish, pulvinose, sometimes coalescent. Mycelium composed of straight, remotely septate brown-olivaceous hyphae, 9–10 μ thick, branched at long intervals. Stomopodia remotely separate, long ellipsoidal, simple, 10–12.5 μ wide. Perithecia dark brown, parenchymatic, astomous, globose, generally attached to the hyphae by a short foot, glabrous, 150–230 μ diam.; asci ovate 100–140 × 50–62 μ, evanescent; ascospores conglobate, 1-septate, cylindrical, 72–94 × 14–17 μ, hyaline when young, smoky brown when old, appearing truncate at both ends. Conidia 2-septate, hyaline with one end truncate.

On *Inga* sp.

COLOMBIA, Antiquia, Envigado, 1540 m., Garcés, Sept. 1942. FC *1814;* Med. *560*.

Coloniis hypophyllis pulvinosis, fuliginosis. Hyphis rectis fuscis-olivaceis, remotis septatis, 9–10 μ densis; stomopodiis remotis separatis, longe ellipsoideis, simplicibus 10–12.5 μ latis, 15–30 μ longis. Perithecia valde fuscis, parenchymatis, astomis, globosis, 150–230 μ diam.; ascis ovatis, 100–140 × 50–62 μ, evanidis; sporidiis conglobatis 1-septatis, cylindraceis, 72–94 × 14–17 μ, fuscis, truncatis utrinque. Conidiis 2-septatis hyalinis, uno apice truncato.

While the general appearance of the present specimen is very much like *Parodiopsis Stevensi* Arnaud, there are several differences which seem to justify the erection of a separated species. These differences consist mainly in the color and septation of the mycelium, the cells of which are 45 to 180 μ long, while in *Parodiopsis Stevensi* they are 30–45 μ long. The shape of the stomopodia is also different; they are long ellipsoidal with acute apex, while those of *P. Stevensi* are almost clavate. The most distinctive character, however, is shown by the ascospores, which have a crown-like appearance at both ends, in contrast to *Parodiopsis Stevensi* which shows one end truncate and the other round.

DIMERIUM COSTARICENSE Syd., Ann. Myc. **24**: 322. 1926.

Parasitic on mycelium of *Schiffnerula monotheca* (Pat. & Gaill.) Pat., on *Rapanea ferruginea* (R. & P.) May, *vel. aff.*

COLOMBIA, Antioquia, Guayabito, between Rionegro and Retiro, 2200 m., Garcés, Feb. 25, 1942. FC *1538;* Med. *246*.

IRENOPSIS MOLLERIANA (Winter) Stev., Ann. Myc. **25**: 437. 1927.

On *Sida* sp.

COLOMBIA, Meta, Villavicencio, 480 m., E. Orjuela, Sept. 12, 1941. FC *1328;* Bog. *916*.

On *Sida acuta* Burm.

COLOMBIA, Meta, Campoalegre, near Villavicencio, E. Orjuela, Sept. 10, 1941. FC *1349;* Bog. *937*.

Our material presents small epiphyllous colonies, sometimes coalescent, scattered all over the leaf surface. The mycelium is reticulate, composed of rather crooked hyphae about 7 μ in diameter, brown, with opposite branching. The capitate hyphopodia are ovoid or lobate, irregular or alternate. Mucronate hyphopodia are opposite. Perithecia about 150 μ diameter, roughened, with 2 to 5 setae which are slightly curved, obtuse or acute and about 85 μ long; asci evanescent; ascospores 4-septate, brown, 35×12.5 μ.

These Colombian specimens were compared with Stevens' specimen, *4184* on *Irenopsis Molleriana* (Winter) Stevens, with which they agree very well in all characters. Stevens and Tehon (Mycologia **18**: 21. 1926) described a new species, *Irene sidicola* on *Sida* sp. Later (**25**) Stevens reduced this to a variety under the name *Irenopsis Molleriana* var. *sidicola*. Judging from the originnal description of *Irene sidicola* it differs from our material in the character of the hyphopodia, in the number of perithecial setae, which is usually one and in the alternate branching of the mycelium.

IRENINA HYPTIDICOLA (Stevens) Stevens, Ann. Myc. **25**: 455. 1927.

On *Hyptis capitata* Jacq.

VENEZUELA, Aragua, Rancho Grande, road Maracay to Ocumare, Chardón, Mar. 25, 1939. FV *2795*.

Irenina Pittieri (Toro) comb. nov.

Irenopsis Pittieri Toro, Mong. Univ. Porto Rico **2**: 114. 1934.

The type FV *371* which is very poor and FV *522* have been examined without discovering perithecial setae. A new collection on

the same host in the same region, shows no perithecial setae either. This fact places the species in the genus *Irenina* rather than in *Irenopsis*. The conidiophores of the conidial stage arise very close to the perithecium, but they are easily distinguishable from the setae by frequently showing still attached conidia. In our material the perithecia reach 325 μ in diameter and the ascospores are 43–45 × 18 μ.

On *Duranta repens* L.

VENEZUELA, Miranda, San Antonio de los Altos, M. F. Barrus and A. S. Müller, Dec. 8, 1939. FV *3664*.

COLOMBIA, Boyacá, near Guateque, R. Obregón, Oct. 24, 1940. FC *1180;* Bog. *623*.

Meliola antioquensis sp. nov.

Colonies epiphyllous, irregular, black, forming large patches on the leaf. Mycelium of straight, opposite branched hyphae, 3 μ thick, dark-brown. Capitate hyphopodia alternate or irregularly disposed; head cell oval to pyriform or cuneiform, 15.5–17 × 11–12 μ; mucronate hyphopodia opposite, bottle shaped, with curved neck. Perithecial setae straight or slightly curved with simple tips, arising mostly at the base of the perithecium; mycelial setae similar, abundant, mostly 260–360 μ long. Perithecia 140–215 μ diam., slightly roughened; asci evanescent; ascospores 4-septate brown, strongly constricted at the septa, with obtuse ends, 44–49 × 15.5–18.5 μ. Beelian formula 3411–4223½.

On *Persea petiolaris* H.B.K.

COLOMBIA, Antioquia, Sabaneta, near Medellín, 1540 m., Garcés, Oct. 9, 1942. FC *1828;* Med. *573*.

Coloniis epiphyllis nigris, irregularibus. Mycelio ex hyphis rectis valde fuscis composito. Hyphopodiis capitatis alternantibus vel irregularibus; hyphopodiis mucronatis oppositis lageniformibus. Perithecialibus setis rectis cum apicibus simplicibus ad basem peritheci plerumque; setis mycelialibus similaribus, abundantibus, 260–360 μ longis. Peritheciis 138–215 diam.; ascis evanidis; sporidiis 4-septatis, fuscis, constrictis, obtusis, 44–49 × 15.5–18.5.

This species differs from *Meliola amphitricha* Fries in the character of the hyphopodia and in the size of the spores which are larger in our specimen. It also differs from *Meliola circinans* Earle in the shape of the hyphopodia which are circinate in the latter species.

MELIOLA HARIOTULA Speg., Rev. Agr. Hist. Nat. Buenoes Aires **1**: 1891.

On *Inga* sp.

VENEZUELA, Táchira, San Cristóbal, J. I. Otero, Oct. 28, 1933. FV *1644*.

Known from Asunción (Paraguay) on leaves of an undetermined *Bignoniaceae* or *Leguminosae*. Our material presents colonies amphigenous, black, circular; mycelium dense, dark-brown formed by straight hyphae about 9 μ thick, branching opposite, slightly constricted at septa. The capitate hyphopodia are opposite, 16 × 9 μ, curved, frequently recurved at the middle, with stock cell small and head cell elongated and sometimes lobed. The mucronate hyphopodia are very rare, lageniform. Mycelial setate very numberous, black, 250 μ long, divided at tip into 2 or 3 short spreading branches. These branches are 15–20 μ long and are simple or dentate at their tips. The perithecia are about 200 μ diam., and more or less rough. The asci are bisporous and evanescent. The ascospores are 4-septate, elliptical with blunt ends, ventrally flattened, dark brown and mostly 45 × 19 μ. Beelian formula 3132–4221.

The type specimen has not been seen but the specimen agrees very closely with Gaillard's description (**11**) except that no pseudoostiolum as described by him, was observed.

MELIOLA LANTANAE Syd., Mem. Soc. Neufch. Sc. Nat. **5**: 434. 1914.

On *Lantana fucata* Lindl.

COLOMBIA, Antioquia, Quebrada Iguaná, near Medellín, 1700 m., Garcés and de Rojas, Aug. 18, 1943. FC *1533;* Med. *273.* Robledo, near Medellín. FC *1841;* Med. *586.*

This is a rather common species already reported from Colombia where the type was collected. A new host is here recorded.

MELIOLA MAKILINGIANA Syd., Ann. Myc. **15**: 188. 1917.

On *Sapanea glomerata* H.B.K.

VENEZUELA, Monagas, Maturín, M. F. Barrus, Jan. 24, 1940. FV *3820*.

The material presents amphigenous colonies which are small, arachnoid and often confluent. The mycelium is formed by rather straight brown hyphae 7.5 μ thick. The capitate hyphopodia are unilateral or alternate, one for each cell. The mycelial setae are crowded around the perithecia, erect, 260–293 μ long, straight or somewhat curved with blunt or slightly swollen apices, sometimes bifurcated (branches 9–12). A new collection made by the author on the same host shows an abundance of setae. The perithecia were found to be up to 300 μ diam.; the perithecial setae 120 μ long, simple, and the mycelial setae 150 μ long, also simple. The ascospores in the new material show a range of 36–39 × 12–15 μ.

MELIOLA PSIDII Fries, Linnaea **5**: 549. 1830.

On *Psidium* sp.

COLOMBIA, Meta, Cano Moroco near Villavicencio, E. Orjuela, Sept. 12, 1941. FC *1334;* Bog. *922*.

Meliola venezuelana sp. nov.

Colonies amphigenous but more developed in the upper surface of the leaf, smoky when young, black when well developed, scattered over the leaf surface, isolated or confluent, circular or irregular in outline. Mycelium formed by light brown, slightly wavy hyphae; branching opposite; hyphal cells 28–34 μ long, 8 μ wide, monohyphopodiate. Capitate hyphopodia regularly spaced, alternate, seldom unilateral, stipitate; basal cell rectangular or trapezoid, 5.6–6.5 μ long, 8 μ wide; head cell cylindrical or slightly clavate, straight, sometimes slightly curved or hooked, 12.5–15.5 × 8.5–9.5 μ. Mucronate hyphopodia ampulliform, opposite, 18.5–22 μ long × 8 μ thick at the base, with a straight neck 12.5 × 3 μ. Perithecia abundant, scattered, spherical or slightly depressed, more or less pellucid with walls distinctly visible, only slightly rough; the larger ones 200 μ diam. Discal setae surrounding the perithecia, erect or sub-erect, 535 μ long, straight or amply curved, simple, 9 μ at the base and gradually tapering toward the apex which is 6 μ thick. Mycelial setae similar to discal setae but scarce; asci 3-spored, evanescent; ascospores 4-septate, cylindrical with blunt ends, slightly constricted at the septa, brown, 44–45.5 × 15.5–18 μ. Beelian formula 311/3 1:5222/3.

On *Pithecolobium ligustrinum* Klotz.

VENEZUELA, Anzoátegui, Barcelona, M. F. Barrus, Feb. 1, 1940. FV *3817*.

Coloniis amphigenis, plerumque epiphyllis, circularibus vel irregularibus. Mycelio opposito ramoso 8 μ crasso; hyphopodiis capitatis alternantibus raro unilateralibus, stipitatis, cellula inferiore aut rectangula aut trapezoide 5.6–6.5 μ longa, 8 μ lata; cellula capitata cylindraceae vel subclavata, aliquando curvata, 12.5–15.6 × 8.5–9.5 μ; hyphopodiis mucronatis lageniformibus oppositis, 18.5–22 μ longis. Peritheciis numerosis, globosis, subpellucidus, 200 μ diam.; setis discalibus erectis, 535 μ longis, vel rectis vel valde curvatis, simplicibus cum apice vel obtuso vel dentato; setis mycelialibus similaribus; ascis 3-sporis, evanidis. Sporidiis 4-septatis, cylindriciis, constrictis, fuscis, 44–45.5 × 15.5–18 μ.

Meliola xylosmicola sp. nov.

Colonies epiphyllous black, circular with radiating margins, 2–3 mm. diam., partially deciduous. Mycelium consisting of brown, opaque, straight hyphae 8–10 μ thick; cells generally 25–30 μ long; branching opposite at acute angle. Capitate hyphopodia alternate, one to each cell, stipitate, 22 × 11 μ, generally forming an angle of 45° with the hyphae; basal cell small, 4 × 9 μ, trapezoid; head cell cylindrical or slightly club-shaped, straight or slightly curved, entire. Mucronate hyphopodia rather scarce, opposite, located near the center of the colony, crowded, 15–24 × 9–10 μ, ampulliform, contorted, frequently opposite a capitate hyphopodium. Mycelial setae scattered or numerous near the perithecial disk, simple, straight, about 570 μ long, 10 μ thick at the base, gradually tapering toward the apex which is pellucid, blunt and 6 μ thick. Perithecia isolated, globose, black, slightly roughened, about 215 μ diam. the larger ones, surrounded by discal setae similar to the mycelial setae but usually shorter, 250 μ long; asci 2-spored, evanescent; ascospores 4-septate, broadly cylindrical with obtuse ends, constricted at the septa, brown, 52–59 × 22–24 μ. Beelian formula 3111-5323.

On *Xylosma spiculiferum* (Clos.) Triana & Pl.

COLOMBIA, Cundinamarca, hills above Facataivá, Chardón, Mar. 28, 1937. FC *1076*.

Coloniis epiphyllis nigris, circularibus cum marginibus radiatis, 2–3 mm. diam. Hyphis fuscis, 8–10 μ crassis, ramis oppositis in angulo acuto; hyphopodiis capitatis alternantibus stipitatis, 22 × 11 μ longis, cellula basali trapezoidea, cellula superiore cylindracea vel clavata; hyphopodiis mucronatis raris, ampulliformibus. Setis mycelialibus simplicibus, rectis, 570 μ longis, apice obtuso. Peritheciis disuntis, globosis, 215 μ diam., circumdatis ab setis discalibus similaribus setarum mycelialium, sed 250 μ longis. Ascis 2-sporis evanidis. Sporiis 4-septatis, cylindraceis, obtusis, constrictis, 52–59 × 22–24 μ, fuscis.

The present species differs from *Meliola Xylosmae* Stev. in the size of the spores which are larger. The species is near *M. Banarae* Stev. from which it differs in the shape of the hyphopodia and the presence of discal setae. The Colombian species also differs from all other species of *Meliola* reported on *Flacourtiaceae* in having much larger spores and setae.

Family TRICHOTHYRIACEAE

TRICHOTHYRIUM DUBIOSUM (Bom. & R.) Theiss., Boih. Bot. Centralb. **32**: 8. 1914.

On *Irenina hyptidicola* (Stevens) Stevens, on *Hyptis capitata* Jacq., Chardón, Mar. 25, 1939. FV *2795*.

On undetermined *Meliolinae*.

VENEZUELA, Monagas, LaPica, Maturín, M. F. Barrus, Jan. 25, 1940. FV *3797*.

The thyriothecia are 84–145 μ in diameter. The asci are 45–50 × 12–15 μ and the ascospores are clavate, 15.6–17 × 3.5–3 μ, the superior cell broader. The conidial tetrades are smooth-walled, about 12 μ in diameter and rather abundant.

Family ENGLERULACEAE

SCHIFFNERULA MONOTHECA (Pat. & Gaill.) Petrak, Ann. Myc. **26**: 397. 1928.

Questeria monotheca (Pat. & Gaill.) Arnaud, Ann. Ecole Nat. Agric. Montpellier **16**: 187. 1918.

On *Rapanea ferruginea* (R. & P.) May *vel affinis*.

COLOMBIA, Antioquia, Guayabito, between Rionegro and Retiro, Garcés, Feb. 25, 1942. FC *1538;* Med. *246*.

Previously recorded in Venezuela and Brazil. Petrak (**18**) considers the genera *Questeria* and *Phaeoschiffnerula* synonyms of *Schiffnerula*. The present specimen presents very slight differences from Theissen's description of *Balladyna monotheca* (Pat. & Gaill.) Theiss. (subsequently changed to *Questeria monotheca* by Arnaud) and therefore does not justify the erection of a new species. Arnaud's plate (**1**) shows the ascospores spiny, a fact that is not mentioned by previous authors, while the Colombian

material presents ascospores with smooth epispore. The spore-wall is rather thick, the outer layer hyaline and refringent, the inner layer clearly brown. The ascospores are a little larger and broader than described, the inferior cell being 36–44 μ long × 20–22 μ wide, the superior one 18–20 μ wide; both cells are almost equally long.

Schiffnerula Rubi Syd., described as having only one ascus, has smaller spores.

Schiffnerula robusta sp. nov.

Colonies epiphyllous, circular, 4 mm. in diameter, scattered or sometimes confluent, black. Mycelium composed of irregularly and frequently ramified and septate hyphae, yellowish brown in color and rather straight, 10 μ thick. Capitate hyphopodia very abundant in the center of the colony, crowded together, more spaced in the margins of the colony, unilateral or alternate, one celled, subglobose, 15–17 μ wide × 13–17 μ high, sometimes very slightly lobed. Perithecia numerous, scattered or loosely gregarious, sometimes aggregated, globose or globose-ellipsoidal, the larger ones 92–170 × 92–110 μ; perithecial roof made of angular or ellipsoidal cells which appear loose after disintegration of the wall at maturity; asci 4–6, broadly ovate or globose, with thickened apices, 8-spored, 72–88 × 56–62 μ; ascospores conglobate, oblong-ovate or ellipsoidal with both ends broadly obtuse, septate near the middle, more or less constricted at the septa, hyaline at first then smoky brown with smooth epispore, 32–34 × 17–18.7 μ.

On *Rapanea* sp.

COLOMBIA, Cundinamarca, Páramo de Chipaque, Chardón, Apr. 1, 1937. FC *1122*.

Coloniis epiphyllis, circularis, 4 mm. diam. nigris. Hyphis saepe ramosis, saepe septatis, 10 μ crassis; hyphopodiis capitatis abundantibus, congestis in media colonia, unilateralibus vel alternantibus, simplicibus, globosis, 15–17 μ latis × 13–17 μ longis; peritheciis numerosis, globosis vel ellipsoideis, 92–170 × 92–110 μ; disintegrantibus maturis; ascis 4–6, late ovatis vel globosis, 8-sporis, 72–88 × 56–62 μ; sporidiis conglobatis, ovatis vel ellipsoideis, 1-septatis, constrictis, fuscis, 32–34 × 17–18.7 μ.

Order HEMISPHAERIALES

In general the criterion of Theissen and Sydow presented for the *Hemisphaeriales* in the *Synoptische Tafeln* (**32**) has been regularly followed in the treatment of the order, with very slight modifications which have been made in order to include the family, *Micropeltaceae* and later erected genera. In doing this the author

follows the leaders in this group, who still consider the general arrangement of that work the most appropriate treatment, in spite of the several papers which have appeared proposing taxonomic changes in the order. Consequently the generic characters established by Theissen and Sydow have been followed, except in the case of the genera *Asterina* and *Parasterina,* which they separated on account of the presence or absence of paraphyses. The difficulty of applying this criterion to species in these genera is so great, in most cases, that it can not be considered a reliable character for distinguishing between them. This fact was pointed out early by Theissen (**29**) in the following paragraph: "The presence or absence of paraphyses can no longer be admitted as a principle, at the same time practical and scientific; not only because it is frequently difficult to verify the presence of true paraphyses and to distinguish them from other interthecial hyphae, but also because such a division would separate species closely related by the combination of their other characters."

Furthermore, mycologists like Petrak (**17**) consider that the presence or absence of paraphyses or paraphysoids alone is a character which can not be used as a generic distinction between hemisphaeric forms. This criterion is also held and emphasized by Doidge (**9**) who merges the two genera, *Asterina* and *Parasterina* into one, *Asterina,* and retains the other name as a section. The author follows Doidge in considering only the genus *Asterina* whether or not the species has paraphyses, but is unaware of the significance of this character among other genera of this order. The necessity for a revision of the group and for a better discussion of the generic characters in the order is imperative.

Family POLYSTOMELLACEAE

POLYSTOMELLA COSTARICENSIS Stevens, Illinois Biol. Monog. **11**²: 23. 1927.

On *Struthanthus* sp.

VENEZUELA, Caracas Agric. Exp. Sta., F. Tamayo, Apr. 3, 1939. FV. *3461.*

This specimen was compared with the type, Stevens' *255* from Costa Rica (CUPP *14710*), with which it agrees very well.

Polyrhizon Capparidis sp. nov.

Colonies epiphyllous superficial, black, crustaceous, circular, 1–5 mm. in diameter, formed by many ascostromata. Thyriothecia black, radiate with entire margins, about 300 μ diam., and 90 μ high, attached to the leaf by a central epidermal hypostroma up to 120 μ thick; asci 8-spored, obovate, with thickened apices when young, broadly cylindrical at maturity, very shortly stipitate, paraphysate, 47–60 × 18–25 μ; ascospores brown, distinchous or inordinate, ellipsoid with round ends, septate near the middle, strongly constricted at the septum, superior cell broader, 21–24 × 8–9 μ. Paraphyses simple or ramified at tips.

On *Capparis flexuosa* Blume.

VENEZUELA, Caracas, A. S. Müller, Sept. 12, 1939. FV *3501.*

Maculis epiphyllis circularibus, nigris, 1–5 mm. diam. Thyriotheciis 300 μ diam., 90 μ altis, a centrale hypostroma epidermale ad folium adiunctis. Ascis 8-sporatis, ovobatis immaturis, late cylindricalibus maturis, paraphysatis, 47–60 × 18–25 μ; sporidiis fuscis, ellipsoideis cum rotundis apicibus, septatis prope medium, ad septum fortiter constrictis, 21–24 × 8–9 μ. Paraphysibus simplicibus vel ramosis cacuminibus.

RHAGADOLOBIUM CUCURBITACEARUM (Rehm) Theiss. & Syd., Ann. Myc. **12**: 275. 1914.

On *Cucurbita maxima* Duch.

COLOMBIA, Antioquia, Rio Nus., near El Limón, 750 m., S. Arango, et al., Mar. 14, 1942. FC *1600;* Med. *324.*

A conspicuous form fairly common in the tropics.

Family MICROTHYRIACEAE

Microthyrium Phoradendri sp. nov.

Colonies amphigenous, more abundant on the underside of the leaves. Ascomata black, circular, superficial, isolated. Free mycelium subhyalin or slightly brown, non-hyphopodiate. Thriothecia radiate, dark brown with lighter center, non-fimbriate border and round pore at the center, 270–300 μ in diameter; asci paraphysate, stout, broadly cylindrical tapering toward both ends, with rounded apex, 69–72 × 14–15 μ; ascospores 15.5–18.5 × 6 μ, hyaline distichous, clavulate with both ends rounded, septum above the middle and constricted superior cell broader, inferior elongated tapering toward the end.

On *Phoradendron* sp.

COLOMBIA, Cundinamarca, Quipile, R. Obregón et al., Apr. 15, 1940. FC *1167;* Bog. *422.*

Coloniis amphigenis in hypophyllo abundatiore. Thyriothecia nigra, circulare, cum foramine circulare, 276–300 μ in diam.; ascis paraphysatis late cylindraceis cum apice rotundato, 69–72 × 14–15 μ; sporidiis distichis, clavatis, uniseptatis, hyalinis, cellula superiore latiore, cellula inferiore elongata, 15.5–18.5 × 6 μ.

This species differs from *Microthyrium Loranthi* (Karst. & Heriot) Theiss., in the size of the thyriothecia and the ascospores.

Microthyrium rhombisporum sp. nov.

Colonies epiphyllous black, circular, aggregated in spots or scattered all over the leaf surface. Free mycelium none or slightly exceeding the fruit body, non-hyphopodiate. Thyriothecia isolated or confluent, applanate, radiate, dark brown or blackish, sometimes greenish, formed of elongated parenchymatic cells which form a fimbriate margin about 75 μ wide; 340–414 μ diam. including the marginal band; pore central, circular; asci ovobate or oblong—pyriform sessile, 8-spored with thickened apex, involved in a mucous mass (aparaphysate?), 62–68 × 19 μ; ascospores distichous or inordinate, rhomboidal, septate near the middle, both ends acute, superior cell broader, inferor cell pointed, not constricted at septum, hyaline, 17–20 × 6.5–7 μ.

On *Rapanea* sp.

COLOMBIA, Antioquia, Robledo near Medellín, 1800 m., Garcés, Dec. 1942. FC *1853;* Med. *598.*

Coloniis epiphyllis nigris, rotundatis. Libero mycelio nullo. Thriotheciis separatis, raro confluentibus, ostiolatis, 340–415 μ diam., cum margine fimbriato 75 μ lato; ascis obovatis, sessilibus, 8-sporis (aparaphysatis?) 62–68 × 19 μ; sporidiis rhomboideis, ad medium septatis, untraque cacumine acuto, cellula superiore latiore, hyalinis, 17–20 × 6.5–7 μ.

This species differs from all other species of the genus described. No species has been reported on *Myrsinaceae.*

Asterinella Bredemeyerae sp. nov.

Colonies punctate, epiphyllous, isolate or confluent, black, 2–3 mm. in diameter. Mycelium scarce, non-hyphopodiate, slightly reticulate. Hyphae branching sparsely, light brown, 3–4.5 μ thick, sub-nodulose in places and frequently septate. Thyriothecia abundant in each colony, rather circular in outline, 185–245 μ diam., with convex, radiate covering membrane, at first light colored, finally dark brown, with shortly fimbriate margin and stellate dehiscence;

asci numerous, ovate when young and broadly cylindrical at maturity, 8-spored, broadly round above, sessile, 47–63 × 15–19 μ; ascospores distichous or conglobate, oblong with both ends rounded, septate near the middle, slightly constricted at septum, buffy-olive in color, smooth, 19–22 × 6.5–9 μ, superior cell broader and shorter. Paraphyses present, filiform.

On *Bredemeyera lucida* (Benth.) Kil.

VENEZUELA, Carabobo, Las Trincheras, M. F. Barrus & A. S. Müller, Feb. 24, 1940. FV *3846*.

Coloniis punctatis, frequentissime epiphyllis, nigris, 2–3 mm. diam. Mycelio raro, non-hyphopodiato. Hyphis parce ramosis, 3–4.5 μ densis, frequenter septatis, subfuscis. Thyriotheciis abundantibus, circularibus, 185–245 μ diam., marginibus fimbriatis, stellatis dehiscentibus, valde fuscis. Ascis numerosis, ovatis inmaturis, late cylindricalibus maturis; 8-sporatis, 47–63 × 15–19 μ; sporidiis distichis, oblongatis, septatis prope medium, leniter constrictis ad septum, fuscis-olivaceis, 19–22 × 6.5–9 μ; superiore cellula latiore. Paraphysibus filiformibus.

ASTERINELLA WINTERIANA (Pasch.) Theiss., Brot. **10**: 122. 1912.

Prilleuxina Winteriana Arnaud, Ann. Ecole Nat. Agric. Montpellier **16**: 162. 1918.

Asterina Winteriana Pasch., Hedwigia **31**: 104. 1892.

Asterina anonicola P. Henn., Hedwigia **41**: 108. 1902.

The genus *Prilleuxina* was erected by Arnaud (**1**) on the grounds that the internal mycelium is connected only with the ascostroma and not with the hyphae of the external mycelium. Strangely enough, Stevens and Ryan (**26**) without amending the original diagnosis make no mention of this fact but separate the genus from *Asterinella* on account of the absence of paraphyses and include under *Prilleuxina* Arnaud, the aparaphysate species of *Asterinella*. As the location of the internal mycelium, in the writer's opinion, does not constitute a generic character, there appears to be no basis for the segregation. On the other hand, as the paraphyses alone are of no generic significance as a distinction between hemisphaeric forms, the author, as we have already said, is inclined to consider, along with Doidge (**9**: 275), that *Prilleuxina* must be united with *Asterinella*.

On *Anona muricata* L.

VENEZUELA, Carabobo, Las Trincheras, A. S. Müller, Jan. 23, 1940. FV *3792*.

The specimen presents only the conidial stage *Leprieurina Winteriana* Arn. Apparently this is the third report ever made of this conidial stage. The conidia are 28–37 × 16–23 μ, a little larger than described by Arnaud, but all other characters agree very well with the original description.

ASTERINA ANTIOQUENSIS (Toro) chart. amend.

Asterinella antioquensis Toro, Jour. Agr. Porto Rico **14**: 232. 1940.

Prilleuxina antioquensis (Toro) Ryan, Illinois Biol. Monog. **17**: 80. 1939.

Colonies epiphyllous, roundish, numerous, frequently anastomosing to form large black patches. Thyriothecia isolated or confluent, 150–200 μ in diam., circular, radiate, with black center and brownish border; marginal hyphae separate leaving round free spaces of the leaf surface exposed giving the stroma a perforated appearance; dehiscence by disintegration of the apical cells; hyphopodiate mycelium brown, wavy, formed by a net of anastomosing, thick walled, septate hyphae 5–6 μ thick; hyphopodia alternate, simple, oval or ellipsoid, 7–9 × 6–7 μ; asci broadly ovate, thick walled, sessile with thickened apex and round base, 53–69 × 31–40 μ; ascospores conglobate, unequally 1-septate, slightly constricted at the septum, 23–25 × 11–12.5 μ, hyaline at first but fuscous at maturity, lower cell sphaerical, broader than the upper ellipsoid cell. Paraphysoids filiform, hyaline.

On *Miconia ciliata* (L. C. Rich) DC.

COLOMBIA, Antioquia, Angelópolis, July, 1927. Toro's FC *246*. On *Miconia theaezans* (Bonp.) Naud.

COLOMBIA, Antioquia, Robledo near Medellín, Garcés, Dec. 27, 1939. FC *1202; 1159;* Bog. 671 and 412. Garcés, Dec. 3, 1941. FC *1550*.

Coloniis epiphyllis, rotundis, numerosis anastomosantibus. Thyriotheciis rotundis, nigris, perforatis ad marginem, 150–200 μ diam; mycelio fusco tortuoso, anastomosanti, 5–6 μ crasso; hyphopodiis alternantibus, simplicibus, ellipsoideis, 7–9 × 6–7 μ ascis late ovatis, pariete cum crasso, sessilibus, 53–69 × 31–40 μ; sporidiis conglobatis 1-septatis, fuscis, cellula inferiore globosa, superiore ellipsoidea, 23–25 × 11–12.5 μ; paraphysoidibus filiformibus.

An examination of Toro's specimen (FC *246*) shows that the fungus has hyphopodia; the species then must be transferred to *Asterina.* According to Toro's key of *Asterina* species on *Melastomaceae* (**33**) the present species falls near *Asterina Schlechteriana* Syd., and *Asterina venezuelana* Syd., but Sydow's descriptions of both of these leaves no doubt that the present species is quite different.

ASTERINA DIPLOCARPA Cooke, Grevillea **10**: 129. 1882.

Asterina similis Cooke, Grevillea **10**: 130. 1882.

Asterina Sidae Earle, Bull. N. Y. Bot. Gard. **3**: 310. 1905.

Asterina sidicola Ryan, Mycologia **16**: 181. 1924.

Toro (**7**) considers the last three mentioned species as synonyms of *Asterina diplocarpa* Cooke. A comparison of the original description of these three species shows that they differ only in unimportant characters, mainly in the size of the ascospores. As Toro found one specimen with variable ascospores measurements, it seems that his assumption is correct. Our specimen was compared with the Venezuelan specimens FV *511, 556* and *756* and was found to agree very well with them all.

On *Sida* sp.

COLOMBIA, Meta, Villavicencio, E. Orjuela, Sept. 12, 1941. FC *1328;* Bog. *916.*

On *Sida acuta* Burm.

COLOMBIA, Meta, Villavicencio, 480 m., E. Orjuela, Sept. 10, 1941. FC *1349;* Bog. *937.*

ASTERINA LIBERTIAE Syd., Ann. Myc. **2**: 167. 1904.

On *Iris* sp.

VENEZUELA, Táchira, Páramo "La Negra," M. F. Barrus and A. S. Müller, Nov. 13, 1939. FV *3653.*

The specimen agrees very well with the description given by Theissen in his monograph of the genus (**30**). The mycelium is composed of wavy brownish hyphae 5 μ thick, which form a reticulate pattern. The hyphopodia are simple, alternate, straight or curved and sometimes lobed, 9 μ long. The ascospores are echinulate, ovate-globose, mostly $28 \times 13\ \mu$, slightly constricted at the septum and with the superior cell slightly broader.

ASTERINA MEGALOSPORA Berk. & Curt., Jour. Linn. Soc. **10**: 373. 1869.

Asterina cubensis Sacc. & Syd. in Sacc., Syll. Fung. **14**: 698. 1899.

Asterella Passiflorae P. Henn., Hedwigia **43**: 82. 1904.

Asterina Passiflorae Sacc., Syll. Fung. **17**: 877. 1905.

These synonyms are given by Theissen (**30**); Sydow (**28**) gives also the following synonyms:

Asterina confertissima Speg., Bol. Acad. Nac. Cienc. Cordoba **23**: 572. 1919.

Asterina Tacsoniae Pat. var. *Passiflorae* Ryan, Mycologia **16**: 183. 1924.

Asterina perconferta Trott. in Sacc., Syll. Fung. **24**: 466. 1926.

On *Passiflora mollisima* (H.B.K.) Bailey.

COLOMBIA, Antioquia, Santa Helena, near Medellín, 2600 m., Garcés et al., June 17, 1941. FC *1400;* Bog. *1145*.

This species was previously reported in Colombia by Chardón and Toro (**6**); a new locality is here recorded. The specimen presents some differences from the Colombian material FC *653* and the Venezuelan FV *497*. The ascospores are smaller in these two specimens and the hyphopodia of the last mentioned are mostly alternate whereas in our specimen they are most frequently opposite or one-sided. Furthermore, many spores present a spiny episporium when old.

ASTERINA MELANOTES Syd., Ann. Myc. **27**: 59. 1929.

Parasterina melanotes Toro, Bol. Soc. Esp. Hist. Nat. **33**: 196. 1933.

On *Miconia granulosa* (Bonp.) Naud.

COLOMBIA, Antioquia, Robledo, near Medellín, 1740 m., Garcés, June 15, 1941. FC *1370;* Bog. *1115*.

The type, from Costa Rica, has not been seen. Two species of *Asterina* occurring on *Melastomaceae*, with lobed hyphopodia, have been described (**33**), *Asterina* (*Parasterina*) *Montagnei* Toro, and *Asterina melanotes* Syd. Our material was compared with the

first mentioned (Toro's FC *321*); they differ in the character of the mycelium and the thyriothecia which in the present species lack the long basal radiating hyphae which characterizes *P. Montagnei.* On the other hand, while the present specimen presents some differences with the original description of *P. melanotes,* most of the general characters agree very well.

ASTERINA PHENACIS Syd., Ann. Myc. **25**: 66. 1927.

On *Phenax hirtus* Wedd.

COLOMBIA, Valle, Highway Cali-Mar, K. 18, Garcés, Nov. 17, 1940. FC *1266*.

Asterina Solanacearum sp. nov.

Colonies mostly epiphyllous, black, circular, 2–5 mm. in diameter, scattered all over the leaf surface and sometimes confluent. Mycelium radiate, tortuose, anastomose-reticulate brown, 3.5 μ thick, with alternate or unilateral, simple, conoid, curved or irregularly shaped hyphopodia 8–9 μ long and 3.5 μ wide. Thyriothecia brown with a violet hue when aged, distinctly radiate throughout the entire covering, 140–300 μ diameter, circular with fimbriate margins, dehiscing stellately with finally complete destruction of the perithecial roof; asci evanescent at maturity; ascospores brown 1-septate, smooth, constricted at the septum, 28 × 14–15.5 μ, with obtuse ends, superior cell slightly larger.

On *Solanum* sp.

COLOMBIA, Cundinamarca, Páramo de Guasca, Garcés et al., Oct. 1939. FC *1203;* Bog. *672*.

Coloniis plerumque epiphylliis, nigris, rotundatis, aliquando confluentibus, hyphis radiantibus, tortuosis, anastomoso-reticulatis, 3.5 μ crassis; hyphopodiis alternantibus vel unilateralibus, simplicibus, conoideis, curvis vel irregularibus, 8–9 × 3.5 μ; thyriotheciis 140–300 μ diam.; ascis evanidis; sporidiis fuscis uniseptatis, constrictis ad septum, 28 × 14–15.5 μ cellula superiore lente maiore.

The present species differs from the other species reported on the *Solanaceae* either in the shape and distribution of the hyphopodia or in the size of the ascospores and perithecia. Comparisons were made with *Asterina coriacella* Speg., FPR *2512* and with *Asterina diplocarpa* Cooke, FPR *2528*. Reported by Toro (**6**) under *Asterina diplopoda* Sydow, from which it differs in having only one kind of hyphopodia and larger spores.

Lembosia Perseae sp. nov.

Colonies epiphyllous forming definite spots 0.5–1 cm. in diameter. Ascostroma superficial, black, elongate and narrow, up to 1 mm. long × 0.1 mm. wide, sometimes coalescing. Mycelium 3 μ thick, thick walled, brown pellucid, remote septate, straight or slightly tortuose, anastomose-reticulate. Hyphopodia scarse or none toward the center of the colony, more abundant at the margin and in young colonies, simple, ovoid, globose or bilobate, 5–6 μ wide, 3–6 μ high; asci globose 28–34 × 15.5–18.5 μ, 8-spored, paraphysate; ascospores brown, 1-septate, 14–16 × 6.5–8.5 μ, constricted at the septum, with obtuse ends, superior cell broader.

On *Persea* sp.

COLOMBIA, Antioquia, "La Leguna" above Medellín, 2500 m., A. Yepes, July, 1942. FC *1642; Med. 388.*

Coloniis epiphyllis 0.5–1 mm. diam. Ascostromatis superficialibus, nigris, elongatis, 1 mm. longis, 0.1 mm. latis. Mycelio 3 μ diam., crasso cum pariete, remote septatis, anastomoso-reticulatis. Hyphopodiis paucis in coloniis senibus, simplicibus, ovatis, globosis vel bilobatis, 5–6 μ latis, 3–6 μ altis; ascis globosis, 28–34 × 15.5–18.5 μ, octosporis, paraphysatis; sporidiis fuscis, 1-septatis, 14–16 × 6.5–8.6 μ ad septum constrictis, obtusis, cellula superiore latiore.

Family MICROPELTACEAE

Parapeltella portoricensis (Speg.) comb. nov.

Micropeltidium portoricense Speg., Bol. Acad. Nac. Cienc. Cordoba **26**: 351. 1923.

On *undetermined* host.

VENEZUELA, Carabobo, Las Trincheras, M. F. Barrus and A. S. Müller, Feb. 24, 1940. FV *3858.*

This new combination is here proposed in order to clarify a situation already pointed out by Stevens and Manter (**23**) who gave however no satisfactory solution to it. The genus *Micropeltis* was created by Montague (**16**: 325) to comprise species with a circular ostiole and hyaline, fusiform, 3-pluriseptate ascospores. Later, Sydow (**27**: 404) erected the genus *Micropeltella* with characters like *Micropeltis* but with paraphyses. Then, Spegazzini (**20**: 212) segregated from the genus *Micropeltis* Mont. the genus *Micropeltidium,* characterized by having astomous thyriothecia, stellate dehiscense and paraphysate asci. The genus

Micropeltella Syd. was likewise divided into *Micropeltella* Syd. with thyriothecia having circular ostioles perforated from the beginning and aparaphysate asci, and *Parapeltella* Speg. with astomous thyriothecia, aparaphysate asci and clavate ascospores.

In a later paper, the same author (**21**: 350) describes again the genus *Micropeltidium,* this time with cylindrical or fusoid ascospores, astomous thyriothecia and aparaphysate asci, and erects 2 species, *Micropeltidium monense* and *M. portoricense,* both species with clavate spores.

The second species, *M. portoricense,* is then placed by Spegazzini (loc. cit: 352) in a section of *Micropeltidium,* which he proposes to name *Metapeltella,* characterized by clavate spores, astomous thyriothecia and aparaphysate asci. It is thus clear that the two species, since they have clavate spores, should be transferred to *Metapeltella,* but a comparison of the genera *Parapeltella* and *Metapeltella,* discloses the fact that there is no difference between them, and consequently *Parapeltella* being first created should stand; the two species must pass to *Parapeltella,* and the genus *Matepeltella* should be discarded.

The Venezuelan material has mostly epiphyllous, blackish, circular, astomous thyriothecia, 500–600 μ in diameter, with a hyaline border about 60 μ wide; dehiscense is stellate. The asci are obclavate, 6–8 spored with rounded apices, 47–62 × 19–25 μ. The ascospores are clavate, 5–6 septate, slightly constricted at the septa, 28–34 × 5.5–6.5 μ. Paraphysoids are abundant.

SACCARDINULA USTERIANA Speg., Rev. Mus. La Plata **15**: 30. 1908.

On *undetermined* host.

VENEZUELA, Carabobo, Las Trincheras. M. F. Barrus and A. S. Müller, Feb. 24, 1940. FV *3858*.

The type has not been seen but the present specimen presents very slight differences from the original description. The thyriothecia are epiphyllous, 460–620 μ in diameter, circular with fimbriate margins, and scattered over the leaf surface. They are brown at the center and cellulose-hyaline at the borders, the covering being plechtenchymatous. A pseudoostiolum is present. The

asci are various in shape and size, globose or broadly ovate with rounded, heavily thickened apex and walls, short stipitate, 47–56 $\times$ 25–35 μ, aparaphysate, 4–8 spored, visible through the perithecial covering and located at the center of the thyriothecium; ascospores conglobate, cylindrical with tip-cells bluntly rounded, straight or curved, usually with 7 cross-septa and 3–5 longitudinal septa, hyaline, 28–33 $\times$ 6.5–9 μ, at first mucose-tunicate, then naked, scarcely constricted at septa or not at all.

The thyriothecia when young present a marginal band of delicate, hyaline mycelium, densely reticulated and having a fimbriate margin, whereas the older ones have simple or entire margins. No ostiolum is found but at the top there is a visible, circular, transparent area which remains even in the larger ascomata. Whether or not this area be lysigenous was not observed. In a cross section of the thyriothecium it is seen that the asci are enclosed in an apical cavity walled-off by a layer of densely interwoven hyaline or brownish hyphae. The shield-cover in the young or almost mature thyriothecia are plechtenchymic in nature but as the thyriothecia grows older the hyphae lose their identity and the structure resembles that of the shield cover of the *Dyctiopeltinae*, though somewhat coarser.

Order DOTHIDEALES

This interesting group of fungi has received preferential attention from Chardón, who has reported a score of new species in several papers (**4–5–6–7–8**) based on collections made by himself and Toro in Colombia and in Venezuela. A few species were also reported a couple of years ago by the writer (**12**) but in relation to the total number of species that must be represented in both countries, the number of already reported species is still very small. As a matter of fact, a large number of species has been collected, which will be the subject of further studies.

The treatment and relationships of this group have been the subject of controversies among mycologists, based principally on the interpretation that each of them gives to the development of the stroma in this and related orders. Recently, light has been thrown on the question by Miller (**14**) in one of the most important contributions on the subject. The artificiality of the

generic characters on which Theissen and Sydow based their well known monograph of the order (**31**) has also been the cause of the reluctancy of many authors to accept it. It seems, however, to be the most modern and extensive treatment, and has been regularly followed by some leaders in the group. The author also follows the treatment but transfers the genus *Bagnisiopsis* to the *Pseudosphaeriales,* under the authority of Miller and Burton (**15**) who have recently made a critical study of the genus, especially with regard to the species occurring in the *Melastomaceae.*

Family PHYLLACHORACEAE

CATACAUMA INGAE Chardón, Jour. Dept. Agric. Porto Rico **13**: 7. 1929.

On *Inga* (*edulis* Mart?).

COLOMBIA, Cundinamarca, Fusagasugá, L. M. Murillo, May 12, 1940. FC *1674;* Med. *421.*

This specimen differs from the original description in having hypophyllous instead of epiphyllous stromata although the portion of compact stromatic tissue situated just above the locule, is also visible on the upper surface of the leaf. The size of the ascospores is a little larger than described for the type, ranging from 26–30 × 4.5–5 μ; oil drops are rather frequent in the ascospores.

Phyllachora Abutilonis sp. nov.

Spots slightly exceeding the stromata. Stromata minute, amphigenous, black, shiny, convex on both sides, circular, 0.2–0.5 mm. diameter, more noticeable on the upper surface of the leaf, mostly unilocular. Locules globose or elliptical, completely immersed in the mesophyll and surrounded by stromatic tissue, 170–280 × 240–370 μ; asci clavate or cylindrico-clavate, 75–90 × 10.5–12 μ, 8-spored, with spores biseriate in the main body of the ascus, or uniseriate; ascospores 1 celled, ovoid, 11–12 × 6.5–7 μ, hyaline. Paraphyses present.

On *Abutilon* sp.

COLOMBIA, Antioquia, Sabaneta near Medellín, 1650 m., Garcés, Sept. 7, 1942. FC *1684;* Med. *431.*

Maculis stromata leniter excedentibus. Stromatis minutis, amphigenis, nigris, circularibus, 0.2–0.5 mm. diam., plerumque unilocularibus. Loculis

globosis vel ellipsoideis in mesophyllo immersis, 170–280 × 240–370 μ. Ascis clavatis vel cylindrico-clavatis, 8-sporatis, 75–90 × 10.5–12 μ; sporidiis ovoideis, 11–12 × 6.5–7.5 μ, hyalinis. Paraphysibus praesentibus.

No species of *Phyllachora* has been heretofore described on *Abutilon; Phyllachora minuta* P. Henn., occurring on *Malvaceae* has smaller spores and the stromatal characters are different.

PHYLLACHORA BOTELOUAE Rehm, Hedwigia **36**: 373. 1897.
On *Chloris radiata* (L) Schw.

COLOMBIA, Valle, Palmira Agric. Exp. Sta., 1000 m., Garcés, Jan. 14, 1941. FC *1673;* Med. *420.*

Phyllachora clavata sp. nov.

Spots amphigenous very conspicuous, irregular or circular in shape with a yellow band usually 2 mm. wide bordering the stromata; stromata amphigenous, black, shiny, slightly raised on the lower, less so on the upper side of the leaf, circular or irregular, 1–7 mm. in diameter, showing many tiny black, raised points. Loculi several in the stroma, lenticular, subglobose or deformed through lateral pressure, immersed in the mesophyll 430–530 × 250–450 μ. Clypeus initiated beneath the epidermis and there of light color; dark stromatic tissue around the locules; asci elongate, subclavate or sub-cylindrical with truncate apices, 8-spored, 110–140 × 15–18 μ; ascospores biseriate or inordinate, hyaline, elongate, straight or slightly curved, with one blunt end, the other acute, 39–45 × 3–6 μ. Paraphyses filiform, abundant.
On *Myrica* sp.

COLOMBIA, Antioquia, Alto "Las Palmas," 2700 m., Hno. Daniel, Feb. 14, 1942. FC *1859.*

Maculis amphigenis subflavis, valde conspicuis, irregularibus vel circularibus, 2 mm. latis iuxta stromata. Stromatis amphigenis nigris, nitidis, circularibus vel angulosis, 1–7 mm. diam. Loculis pluribus, lenticularibus, subglobosis vel deformatis, in mesophyllo inmersis, 430–530 × 250–450 μ. Ascis elongatis, subclavatis vel subcylindraceis cum truncato apice, 8-sporatis, 110–140 × 15–18 μ; sporidiis distichis vel inordinatis hyalinis, elongatis, rectis vel leniter curvatis, clavulatis, altero apice obtuso, altero apice acuto, 39–45 × 5–6 μ Paraphysibus filiformibus abundantibus.

The shape and the size of the ascospores as well as the conspicuous appearance of the yellow band around the stromata distinguishes this species from any other described on *Myrtaceae.*

PHYLLACHORA DIOCLEAE P. Henn., Hedgwigia **43**: 252. 1904.

On Dioclea sericea H.B.K.

COLOMBIA, Valle, Highway Cali-Al Mar, K. 3, 1150 m., Garcés, Nov. 17, 1940. FC *1857*.

The type was not seen; comparisons were made with *P. Diocleae* P. Henn. on *Dioclea reflexa* Hook from Costa Rica (Stevens' *876*, CUPP *14676*); while the characters of the asci and ascospores closely agree, the appearance of the stromata in the Colombian material is very different. They are black, flattened and forming almost concentric, broken rings, about 1–2 mm. wide.

Phyllachora gynericola sp. nov.

Stromata amphigenous, black, isolated, ellipsoid or circular, 1–3 mm. long × 1–1.5 mm. wide, bordered by a narrow discolored zone, and often in the center of oval, large grayish-brown or ashy spots. Loculi 3–5 in each stroma and immersed in the mesophyll, globose or irregular in shape and completely surrounded by a black, heavy stroma. Asci clavate or saccate, paraphysate, 8-spored, pedicellate when young, with a spore body of 115–140 × 30–36 μ, with spores distichous or inordinate; ascospores hyaline, simple, elliptic-elongate when young and finally angular or deformed, usually with one blunt end and the other pointed, 30–33 × 11–12.5 μ. Paraphyses filiform, abundant.

On *Gynerium saccharoides* H.B.K.

COLOMBIA, Antioquia, Sabaneta, Medellín, 1650 m., Garcés, Sept. 7, 1942. FC *1677*; Med. *424*.

Stromatis amphigenis nigris, isolatis, ellipsoideis vel circularibus, 1–3 mm. × 1–1.5 mm. diam. zonula angusta et decolorata cinctis et saepe in mediis maculis ovatis et magnis. Loculis 3–5 in utraque stroma, in mesophyllo immersis, globosis vel irregularibus. Asci clavatis vel sacciformibus, paraphysatis, 8-sporatis, sporato corpore 115–140 × 30–36 μ; sporidiis distichis vel inordinatis, hyalinis, elliptico-elongatis inmaturis, deformatis maturis, 30–33 × 11–12.5 μ. Paraphysibus filiformibus abundantibus.

Apparently, this is the first report of a species of *Phyllachora* on *Gynerium*. This is a conspicuous and beautiful *Phyllachora* commonly found all through the Medellín Valley.

PHYLLACHORA NOTABILIS Petrak & Cif., Ann. Myc. **28**: 396. 1930.

On *Stigmatophyllon* sp.

COLOMBIA, Valle, Highway Cali-Al Mar, K. 22, 2200 m., Garcés, Nov. 17, 1940. FC *1856*.

Although our specimen differs slightly from the original description in that it shows epiphyllous or hypophyllous stromata, in most of the other characters it agrees very well. The other species of *Phyllachora* on *Stigmatophyllon*, *P. inconspicua* Chardón, is quite different as shown on close examination of FPR *901*.

PHYLLACHORA OXYSPORA Starb., Bih. Sv. Vet-Akad. Handl. **25**: 45. 1900.

On *Sorghastrum stipoides* (H.B.K.) Nash.

COLOMBIA, Antioquia, Normal de Varones, Medellín, 1750 m., Garcés et al., Dec. 3, 1941. FC *1860*.

PHYLLACHORA SPHAEROSPERMA Winter, Hedwigia **23**: 170. 1884.

On *Cenchrus Brownii* Roem & Schult.

COLOMBIA, Valle, Palmira Agric. Exp. Sta., 1000 m., Garcés, Jan. 14, 1941. FC *1672;* Med. *419*.

This specimen was compared with *P. sphaerosperma* on *Cenchrus equinatus* (FPR *928*) and shows no difference from the Porto Rican material. The ascospores are globose, 8.5–9 μ in diameter and hyaline. No darker spores were found which would lead to the transfer of the species to the genus *Sphaerodothis*, as suggested by Stevens and Moore (Illinois Biol. Monog. **11**: 43. 1927).

PHYLLACHORA VISMIAE Stevens, Illinois Biol. Monog. **11**: 41. 1927.

On *Vismia latifolia* Choisy.

COLOMBIA, Meta, near Villavicencio, 498 m., E. Orjuela, Sept. 12, 1941. FC *1858;* Bog. *839*.

Sphaerodothis Merianiae sp. nov.

Spots brown, conspicuous, amphigenous, 3–7 mm. diam. Stromata hypophyllous, black, not shining, convex and circular, 1–1.5 mm. in diam., mostly diloculate. Locules globose, very large, 460–620 × 500–770 μ, immersed in the mesophyll and surrounded on all sides by black stromatic tissue; asci cylindric-saccate, 8-spored, 230–240 × 25–37 μ, with spores uniseriate, biseriate or inordinate; ascospores elliptical with blunt ends, continuous, at first orange-

yellow in color, finally brown, 25–31 × 16–19 μ. Paraphyses filiform, abundant.

On *Meriania nobilis* Triana.

COLOMBIA, Antioquia, Rionegro, 2400 m., Garcés et al., Oct. 1942. FC *1802;* Med. *548.*

Maculis amphigenis conspicuis, 3–7 mm. diam. Stromatis hypophyllis nigris, circularibus, 1–1.6 mm. diam., biloculatis. Loculis globosis, 460–620 × 500–770 μ diam., in mesophyllo immersis et ab stromatico textu circumdatis. Ascis cylindrico-saccatis, 8-sporatis, 230–240 × 25–37 μ; sporidiis monostichis, distichis vel irregulariter dispositis, 25–31 × 16–19 μ. Paraphysibus filiformibus abundantibus.

Order PSEUDOSPHAERIALES

BAGNISIOPSIS AMADELPHA (Syd.) Petrak, Hedwigia **68**: 280. 1928.

On *Miconia caudata* DC.

COLOMBIA, Antioquia, Robledo, near Medellín, 1750 m., Garcés, July 1942. FC *1652;* Med. *399.*

On *Miconia granulosa* (Bonp.) Naud., Robledo, 1750 m., Garcés, June 15, 1941. FC *1370;* Bog. *115.*

According to Miller and Burton (**15**) this species was reported by Chardón (**6**) under the name *Dothidina peribebuyensis;* a new host and a new locality are here recorded.

Bagnisiopsis miconicola sp. nov.

Stromata hypophyllous, verrucose with setae-like processes, black, 0.5–1 mm. diam., occurring in groups of 4 to 5, causing small, dark spots on the upper surface of the leaf. Locules simple, large, globose, 320 × 290–600 × 500 μ; asci cylindrical, 8-spored, paraphysate, long stipitate, with rounded apex, 230–260 × 18.5–19.5 μ; ascospores monostichous, hyaline, with a slight greenish-blue hue, thick-walled, elliptical with both ends acute, 18–21 × 9–10 μ. Paraphyses filiform, abundant.

On *Miconia squamulosa* Triana.

COLOMBIA, Cundinamarca, Hills above Usaquén, 3000 m., Garcés et al., Oct. 3, 1939. FC *1861.*

Stromatis hypophyllis 0.5–1 mm. diam. nigris. Loculis simplicibus, globosis, 320 × 290–600 × 500 μ. Ascis cylindraceis, 8-sporatis, paraphysatis, longe stipitatis, rotundato apice, 230–260 × 18.5–19.5 μ. Sporidiis monostichiis, hyalinis colore subviridi, densis parietibus, ellipsoideis, 18–21 × 9–10 μ. Paraphysibus filiformibus abundantibus.

According to Miller and Burton (**15**: 315) of the species of *Bagnisiopsis* on the *Melastomaceae* with dark stromata only two *B. Toledoi* Chardón, and *B. amadelpha* (Syd.) Petrak have setae-like processes. The present specimen differs from both of these in the size of the loculi, asci and spores. A comparison with the type of *B. Toledoi* and with *B. amadelpha* FV *443* leads to the conclusion that they are different from the Colombian species.

BAGNISIOPSIS PERIBEBUYENSIS (Speg.) Theiss. & Syd., Ann. Myc. **13**: 292. 1915.

On *Miconia versicolor* Naud.

COLOMBIA, Cauca, road between Popayán and Puracé, 2600 m., E. Perez et al., July 10, 1939. FC *1676;* Med. *423.*

Chardón (**6**) reports *Dothidina peribebuyensis* (Syn. = *Bagnisiopsis peribebuyensis* (Speg.) Theiss.) on *Miconia* sp. but according to Miller and Burton (**15**: 329) Chardón's specimen is *B. amadelpha* (Syd.) Petrak.

MAIREELLA ANDINA (Chardón) Petrak, Ann. Myc. **38**: 210. 1940.

On *Mikania Ruiziana* Poepp.

COLOMBIA, Cundinamarca, "La Cadena," road Bogotá-Girardot, 2850 m., R. Obregón et al., June 4, 1941. FC *1469;* Bog. *1214.*

This collection was compared with Chardón's FC *447b* previously described under *Uleodothis andina* Chardón (**6**). Chardón's material also has brown spores. Our specimen agrees in all details with it, except in that only epiphyllous stromata are present. Jenkins (**13**: 397) considers this species might be similar to *Achorella guianensis* Stevens, which she transfers to *Maireella guianensis.* A comparison of Stevens' species (CUPP *16790*) with Chardón's material FC *447b* shows a close similarity between them except for the size and shape of the asci which are shorter and more cylindrical in *Maireella guianensis,* while in *Maireella andina* they are clavate. It is however highly probable that a critical comparison of both species will show that Jenkin's assumption is correct.

A new locality is here recorded for the species.

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A NEW DISCOMYCETE FROM THE OLYMPIC NATIONAL FOREST[1]

Bessie B. Kanouse

Among the numerous discomycetes that were obtained by Dr. A. H. Smith in the Olympic National Forest, Washington, is one for which the writer can find no description. It is described here in the family Helotiaceae, tribe Ciborideae. It was collected on decayed leaves of *Alnus* sp. June 3, 1939.

Pseudociboria gen. nov.

Apothecia parva, brevissime stipitata, sine stromate, ceraceo-coriacea, brunnea aut nigra, plane expansa, minute crenulato margine, extrinsecus striata; hypothecia prosenchymatica, nongelatinosa, asci cylindracei, 8 sporis; ascosporae hyalinae, ellipsoideae, unicellulares; aliae paraphyses hyalinae, nonseptatae, 1 μ diam., aliae paraphyses atro-brunnea, nonseptatae 4 μ diam.

Type species *P. umbrina*.

Apothecia small, stipitate to substipitate, lacking a stroma, waxy coriaceous, dark brown to blackish brown, disc plane, marginate, externally striate; hypothecium prosenchymataceous, nongelatinous; asci cylindrical clavate, 8-spored, spores ellipsoid to subovoid, 1-celled, hyaline; paraphyses of two kinds, one kind filamentous, hyaline, 1 μ in diameter, the second kind cylindrical, dark brown, 4 μ in diameter, epithecium lacking.

Pseudociboria umbrina sp. nov.

Apothecia 1–1.5 mm. lata, brunnea, stipitata, sine stromate, extrinaceus striata, plana, crenulato margine, non-gelatinosa; hypothecia prosenchymatica; stipites brunnei, .75–1 mm. alti, longitudinaliter striati; asci cylindracei, 55–70 × 6–7 μ, 8 sporis, J–; sporae ellipsoideae vel subovoidae, 5.5–7 × 3.5–4 μ, unicellulares, hyalinae; aliae paraphyses hyalinae, nonseptatae filiformes 1 μ diam., aliae paraphyses brunneae, nonseptatae, filiformes, 4 μ diam.

In emortis foliis Alni. Specimen typicum legit prope Lake Crescent, Olympic National Forest, Washington, June 3, 1939. A. H. Smith *18933*. Herb. Univ. Mich. conservatum.

Apothecia foliicolous, stipitate, arising from leaf blades or veins, without stroma, stipe 1 mm. long, .5 mm. wide, expanding rather

[1] Papers from the Herbarium of the University of Michigan.

abruptly into the disc, externally longitudinally striate, dark brown to black-brown; disc plane remaining expanded on drying, .75–1 mm. in diameter, concolorous with the stipe, margin minutely crenulate with the free ends of the bundles of the excipular cells, apothecium entirely prosenchymateous, nongelatinous, cell walls light brown, contents hyaline, the point of the inverted cone-shaped central core extending into the top of the stipe, excipular cells forming a thick, more or less firm layer, cell walls and contents colored brown, outer excipular cells decorated with longitudinal striations or irregular netting of dark brown cells; hymenium composed of asci and 2 types of paraphyses, asci cylindrical-clavate, 55–70 × 6–7 μ, 8-spored; spores typically obliquely uniseriate in the asci; spores ellipsoid to subovoid, 5.5–7 × 3.5–4 μ, hyaline, 1-celled; hyaline paraphyses filiform, 1 μ in diameter, nonseptate, not forming an epithecium, colored paraphyses narrowly cylindrical, 4–4.5 μ in diameter, filled completely with a dark brown coloring matter, apices rounded, nonseptate, no forming an epithecium. Apothecium not stained blue with iodine. Dark brown cell contents soluble in KOH, solution becomes stringly and quickly stained a bright pinkish red.

Conidial stage unknown.

On decayed leaves of *Alnus* sp., Lake Crescent Olympic National Forest, Washington, June 3, 1939. A. H. Smith *18933*. Type deposited in the Herbarium of the University of Michigan.

The morphological characteristics exhibited by this fungus require the establishment of a new genus. It belongs in the family Heliotiaceae, tribe Ciborideae. Because of the absence of a sclerotium it can not be placed in the genus *Sclerotinia*. White [2] has delimited the genus *Ciboria* as follows: "true Ciborias . . . are associated in nearly all cases with inflorescences; they apparently rarely if ever occur on wood, stems or leaves. They completely stromatize the floral structure in the form of a mummy." Our fungus has no stroma and it is foliicolous. With respect to the genus *Rutstroemia,* White (l.c.) names several fundamental characters that he says distinguish the genus. Among them are: presence of stroma; production of spermatia; apothecia having a middle gelatinized zone in the ectal excipulum; ascospores becoming one to several septate at maturity; production of apothecia in

[2] White, W. Lawrence. A monograph of the genus *Rutstroemia* (Discomycetes). Lloydia **4**: 153–240. 1941.

late summer and early fall. On all of these counts our fungus differs from the genus *Rutstroemia*. An outstanding difference between our fungus and the genera mentioned above, is the presence, in *P. umbrina*, of hyaline and of colored paraphyses. The occurrence of two kinds of paraphyses is, as far as the writer is aware, a character not known in any other discomycete. Colored paraphyses are found in species of *Rutstroemia* and *Ciboria*. But in all cases they are the only type produced and the coloring matter is restricted to the upper portion of the paraphyses and is usually a light or golden brown color. In *P. umbrina* the colored paraphyses are produced in addition to the colorless ones. The pigmentation is dark brown and is distributed throughout the entire length of the filaments. Sections mounted in water show that the coloring matter is not water soluble. It is broken up into short sections resembling beads. The color is a dark brown. Sections mounted in dilute KOH show a striking chemical reaction which is a good specific character. In KOH solution the coloring matter is immediately dissolved producing a bright pinkish red color in the solution. The pigment in the colored paraphyses and in the colored excipular cells reacts the same. The heretofore dark cells quickly become pale pinkish in color, with the tint evenly distributed within the cells. From sections so treated it can be seen that no cross walls are present in the paraphyses that were formerly brown. Iodine solution does not stain any portion of the apothecium blue. Both types of paraphyses arise from the lower part of the hymenial layer. This portion is very compact and it is difficult to determine, even in section, the actual origins of either asci or paraphyses. However, the colored contents of the larger paraphyses makes it possible to see that they arise from the same hymenial tissue as the asci and hyaline paraphyses. The colored paraphyses are not at all like setae. The tips are rounded and the walls are thin.

Studies made from cross sections of the fungus show an inverted cone of hypothecial tissue that is entirely prosenchymateous. The cell walls are light brown in color and the contents are nearly hyaline. The cell walls are thin and the hyphae are intricately interwoven. This core of tissue connects directly with the excipular layer, and above with the hymenium. There is no gelatinous layer.

In microscopical mounts the hymenium can be forced out leaving the excipular shell nearly intact. The netted appearance of the outermost layer of excipular cells can then be plainly seen. This net becomes radially striate near the base of the cups and the striations extend downward longitudinally the length of the stipe. Upward the strands form the shallow crenulate margin. The free ends of these hyphae are arranged in small bundles of from 10–15 ends in each bundle. The tips of these hyphae are rounded. The scallops formed by them are not tooth-like nor do they form a fringe.

The asci and spores are typically those of *Ciboria spp.* The lack of a stromatic condition and the presence of the two types of paraphyses make it necessary to erect a distinct genus for the fungus.

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A NEW RUST OF ORCHIDS

DAVID H. LINDER [1]

(WITH 8 FIGURES)

Among the interesting genera that have been assigned by Dietel (2) to the tribe Ravenelieae of the Pucciniaceae, belongs the genus *Sphenospora* which occurs in Africa, but primarily in the American tropics. The genus occurs on such widely separated host genera as *Dioscorea, Smilax* and *Copaifera,* and to these must now be added *Epidendrum* of the Orchidaceae. The material about to be described was received from Dr. A. G. Kevorkian through the kindness of Prof. W. H. Weston, Jr., who turned it over to the writer for study and determination. It is indeed a great pleasure to the writer to dedicate this species to Dr. Kevorkian, not only because of his interest in the orchids, but more especially because of his many collections of interesting fungi of the tropics.

Sphenospora Kevorkianii sp. nov. (FIG. 1–8)

Pycnia et aecia ignota. Uredosori hypophylli, subepidemales, primum tecti, hemisphaerici, demum erumpentes subcupulatique, aparaphysati; uredosporae ellipsoideae, obovatae vel subsphaericae, 28–33 × 18–26.5, membrana flavida, 1.5–3.3 μ cr., echinulata, poris germinalibus obscuris, 1 vel (?)2, aequatorialibus; teleutosori hypophylli in maculis irregulariter vel circulariter instructi, atro-fusci vel atri, usque ad 1 mm. diametro; teleutosporae obovoideae vel ellipsoideae parietibus hyalinis tenuibusque praeditae, 23–28 × 13–16.5 μ, primum unicellulatae deinde longitudinaliter 1-septatae, cellula utraque basidium unicum sessile (1)-2-(3) septatum et ± 33 × 6.5 μ gerens, pediculi teleutosporarum hyalini, robusti, 41–66 × 6.5–8.3 μ a cellula magna oriente; paraphyses numerosae, clavate vel cylindricae, rectae vel conspicue recurvatae, primum dense luteo pigmentatae, parietibus tenuibus praeditae, 100–116 × 8–10.5 μ.

Pycnia and **aecia** unknown. **Uredosorus** hypophyllous, subepidermal, at first covered and hemispherical, then erumpent and subcupulate, aparaphysate. **Uredospores** ovoid, ellipsoid or subspherical, 28–33 × 18–26.5 μ, the membrane yellowish, echinulate, 1.5–3.3 μ thick, the germ-pores obscure, one or possibly two, equa-

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, No. 206.

torial. **Teleutosori** hypophyllous in light colored spots, arranged irregularly or loosely clustered in circles, dark brown or black, or lighter colored from the uredospores that remain in the sorus, up to 1 mm. in diameter, subepidermal. **Teleutospores** obovoid or ellipsoid, thin-walled, 23–28 × 13–16.5 μ, at first one-celled but becoming longitudinally one-septate, each cell soon bearing a single basidium that is (1–)–2–(3–) septate. **Basidiospores** hyaline or yellowish from the scattered droplets of pigment, globular, ovoid, or irregularly ovoid and mostly apiculate, 8.2–11.5 × 6.5–7 μ. **Paraphyses** numerous, clavate or cylindrical, straight or strongly curved or even coiled at or near the apex, thin-walled, 100–116 × 8–10.5 μ, at first densely filled with cytoplasm and yellow pigment, then losing their contents and becoming hyaline, either in clusters at the margin of the sorus or singly among the teleutospore pedicels where they arise from the same large basal cells.

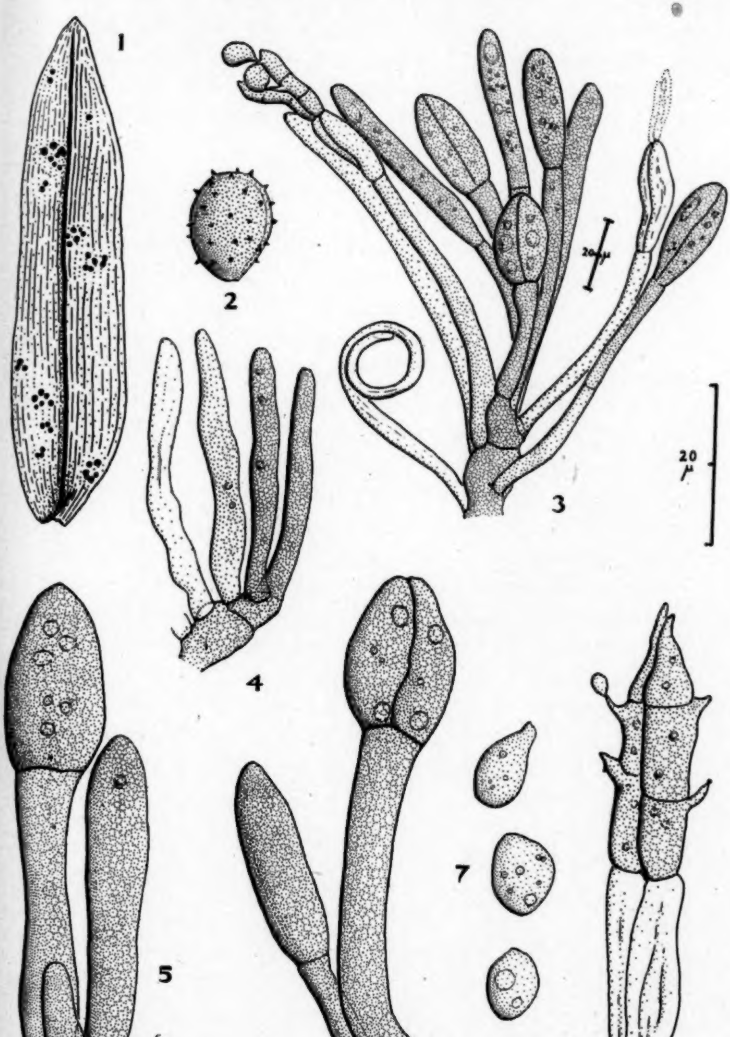
On *Epidendrum difforme,* causing considerable damage, Bilwas Karma, Departmento El Capo, Nicaragua, April 6, 1943, *A. G. Kevorkian,* **type.**

This species is of interest not only because it is parasitic on a member of the Orchidaceae, but also because of its development. The fungus possesses marginal paraphyses in addition to those formed among the teleutospores where they arise from the same large cells that might be termed the teleutospore mother-cells. The teleutospores in the very early stage of development are difficult to distinguish from the paraphyses, but shortly after the future stalk cell (which attains dimensions of 41–66 × 6.5–8.3 μ) has reached a certain size, it begins to enlarge at the apex and then the terminal cell is cut off by the formation of a septum. Shortly thereafter, the terminal cell, having become abruptly enlarged (FIG. 5), becomes longitudinally septate to produce two cells, each of which quickly germinates by the production of a three-celled, rarely a two- or four-celled basidium (FIGS. 6, 7). However, prior to the formation of the basidia from the apices of the cells of the teleutospore, there is a tendency for the two cells to separate near the apex, either as a result of the elongation of the tips prior to basidium formation or else from internal pressure of the spore that pushes them apart. This tendency of the apices of the teleutospore to split recalls Cummins' (**1**) statement in regard to *Ypsilospora* that "The arrangement of two teliospores upon a common pedical is similar to that which characterizes the teliospores of

Sphenospora, except that here the two spores have no common wall. It should be noted that the teliospores of *Sphenospora Copaiferae* (P. Henn.) Syd. are described (Monogr. Ured. **4**: 584. 1924) as '. . . am Septum meist ziemlich tief eingeschnürt. . . .' "

If the splitting of the teleutospore is significant, as has been suggested by Cummins (**1**), then *Sphenospora* is allied to *Ypsilospora* and this genus is in turn related to *Olivea* and *Chaconia* since these two last named genera may be considered as having arisen from *Ypsilospora* through the aggregation of the free teleutospore pedicels into a dense compound stipe. *Ypsilospora* thus differs from *Olivea* much in the same manner as *Uromycladium* or *Cystomyces* differs from *Ravenelia* excepting that in this latter instance, the stipe cells of *Ravenelia* have remained long and slender instead of becoming short through septation. This difference would not seem unusual when it is considered that two different series of forms have undergone a more or less parallel evolution. If all of these genera were brought together in the Raveneliae, it would then seem logical to include *Maravalia* in the series between *Ypsilospora* and *Chaconia* or *Olivea*, an arrangement that would bring together those forms that appear to have evolved primarily on the Leguminosae and which furthermore have certain morphological characters in common. According to this disposition of the genera, it is suggested that the tribe Oliveae either be dispensed with or reduced to subtribal rank and the Raveneliae be considered a tribe which would then consist of two series, at least, one of which terminates with *Chaconia* or *Olivea* and the other that terminates with *Ravenelia* or a closely related genus. Since this

FIGS. **1–8**: all figures except 1 and 3 are shown at a magnification of × 1150, the others are natural size and × 550 respectively, **1**, a relatively heavily infected leaf of *Epidendrum difforme* showing the distribution of the hypophyllous teleutosori; **2**, a characteristically shaped uredospore; **3**, elements of the hymenium showing the large basal cells from which arise the teleutospores and the cylindrical paraphyses, some of which have lost their contents; **4**, enlarged basal cells bearing only paraphyses; **5**, at the left a teleutospore initial which has enlarged after becoming separated from the stipe by a septum; **6**, a teleutospore initial which has become longitudinally septate; **7**, basidiospores which illustrate variation in shape; **8**, a teleutospore initial which, having formed two teleutospores, has germinated to form two basidia.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treatment of the Raveneliae is at variance with the ideas of Dietel (**2**) and Mains (**3**) and other uredinologists, it will be interesting to see if future cytomorphological studies bear out these conclusions.

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THE MORPHOLOGY AND TAXONOMY OF ALTERNARIA CITRI [1]

DONALD E. BLISS AND H. S. FAWCETT

(WITH 5 FIGURES)

INTRODUCTION

The original description of *Alternaria Citri* Ellis and Pierce was published in 1902 by Newton B. Pierce (**26**), in a short article entitled "Black Rot of Oranges." Ten years earlier, this disease had been reported in connection with investigations, presumably by Pierce, in California. In this report (**18**, p. 238–239), it was stated that the black rot of navel oranges had only recently attracted the attention of orange growers in California, that the distribution of the disease in California was as wide as that of the navel orange itself, that the disease was caused by a new species of fungus belonging to the genus *Macrosporium,* and that it brought about premature ripening and fall of the fruit, with an incidence as high as 10 per cent in some cases.

In 1901, J. H. Reed (**27**), a prominent citrus grower at Riverside, California, evidently unaware of any previous work on the black rot of oranges, and without referring to any fungus or disease by name, described the black-rot condition and estimated that fruit losses for that season were from 10 to 30 per cent. Apparently replying to Reed's article, Pierce (**25**) stated that "this disease was thoroughly investigated at Riverside and elsewhere in Southern California by the Department of Agriculture some six or eight years since, and the main facts were given to the public."

In his description of the fungus, Pierce (**26**) states that single-spore cultures had been made and that "detailed descriptions and illustrations are reserved for publication, together with facts relative to preventive treatment." Unfortunately, these data were apparently not published. As far as can be ascertained, no fungus material studied by Ellis and Pierce is available for examination.

[1] Paper No. 509, University of California Citrus Experiment Station, Riverside, California.

In the absence of such original material, uncertainty has arisen as to the characteristics and limits of *Alternaria Citri*, and as to the identity of related fungi on other fruit crops and on citrus in other parts of the world.

Alternaria Citri, or closely allied forms, have been reported in many countries where citrus is grown. In California the fungus is widespread and may be found on all the aerial parts of citrus trees. *A. Citri* has been isolated from desert air at considerable distances from citrus trees (**9**), and an *Alternaria*, possibly of the same species, has been obtained from air over the ocean 400 miles off the coast of California (**28**). The following list, showing localities where observations or studies were made, authors, and dates of published reports,[2] emphasizes the wide geographic distribution of *A. Citri*.

United States—*California:* Smith, 1909; Fawcett, 1912, 1915, 1922, 1923, 1925, 1926 (**13**), 1927, 1929 (**14**), 1936 (**15**); Amundsen, 1913 (**1**); Coit and Hodgson, 1916, 1918 (**8**), 1919 (**9**); Bartholomew, 1923 (**2**), 1926 (**3**); Barger, 1928, 1933; Horne *et al.*, 1930; Savastano and Fawcett, 1929 (**33**); Brooks and McColloch, 1936; Fawcett, Klotz, and Nixon, 1936 (**17**). *Arizona:* Coit, 1908; George, 1922. *Texas:* Fawcett, 1936 (**15**). *Florida:* Fawcett, 1911, 1912; Stevens, 1919; Burger, 1922, 1923, 1936; Rhoads and De Busk, 1931; Winston, 1937; Ruehle, 1937 (**31**). **Cuba**: Horne, 1912; Johnston and Bruner, 1918; Bruner, 1921. **Puerto Rico**: Stevenson, 1918. **Argentina**: Blanchard, 1931; Green, 1932; Marchionatto, 1933. **Uruguay**: Acosta, 1931; Fawcett and Bitancourt, 1940. **Paraguay**: Fawcett and Bitancourt, 1940. **Italy**: Sibilia, 1930; Montemartini, 1931; Cocchi, 1931; Fawcett, 1931, 1936. **Portugal** (including **Azores**): Coutinho, 1929; Fawcett, 1931. **Spain**: Kidd and Tomkins, 1928; Fawcett, 1936 (**15**). **Morocco**: Malençon and Delécluse, 1937. **Greece**: Sarejanni, 1935. **Cyprus**: Natrass, 1932, 1933. **Egypt**: Briton-Jones, 1925; Melchers, 1932; Fawcett, 1936 (**15**). **Palestine**: Reichert, 1927; Kidd and Tomkins, 1928; Reichert and Perlberger, 1928;

[2] Numbers in parentheses indicate reports of special pathological or mycological interest, included in "Literature Cited" at the end of the present paper.

Fawcett, 1931. **Russia**: Maklakova, 1932; Tzereteli and Tchanturia, 1939. **Southern Rhodesia**: Hopkins, 1930; Bates, 1936, 1937, 1939. **Union of South Africa**: Doidge, 1924, 1929 (**11**), 1931; Webber, 1925; Evans, 1925, 1929, 1936, 1937; Kidd and West, 1928; Barker, 1928; Doidge and Van der Plank, 1936; Van der Plank *et al.*, 1938; Wager, 1939 (**35, 36**). **Northern India**: Chaudhuri, 1936. **China**: Yu, 1934; Teng, 1940; Wei, 1940. **Japan**: Fawcett, 1936 (**15**). **Australia**: Stoward, 1913; Adams, 1923; Kidd and Tomkins, 1928; Young and Read, 1932; Hall, 1938.

Side spot decay of dates, caused by a similar form of *Alternaria*, has been investigated in Arizona by Brown (**7**), and in California by Fawcett and Klotz (**16**), and by Turrell, Sinclair, and Bliss (**34**). A leaf spot of sweet cherry was studied by Rudolph (**30**), who considered the fungus to be a variety of *Alternaria Citri*.

Although widely distributed in other parts of the world, *Alternaria Citri* appears not to have been reported from tropical countries. The fungus is not mentioned in available reports from the Philippines, Java, Southern India, the middle tropical parts of Africa, Panama, Central America, and the tropical states of South America. In view of the fact that the junior author, in studies in Brazil, found no *Alternaria* in thousands of oranges of different varieties, it is believed that this lack of reports from the tropics may be significant.[3]

The purpose of this paper is to present what the writers consider to be a reasonable concept of *Alternaria Citri* as a species. This concept is based not only on the original description by Ellis and Pierce (**26**), but also on studies of a considerable number of isolates from navel oranges collected in various localities in southern California, including some of those localities where Pierce obtained his specimens.[4] An emended description of the species has been

[3] Since this was written, an unidentified specimen of *Alternaria* sp. (probably not *A. Citri*) on citrus leaves has been received from Dr. A. A. Bitancourt, Instituto Biologico, São Paulo, Brazil. He states that *Alternaria* has been found only rarely on *Citrus* in Brazil.

[4] Pierce was Special Agent in California, U. S. Department of Agriculture, Division of Vegetable Pathology, in charge of the Pacific Coast Laboratory of the Bureau of Plant Industry, Santa Ana, California. He mentioned specifically (**25**) that the black rot of oranges was investigated especially at Riverside.

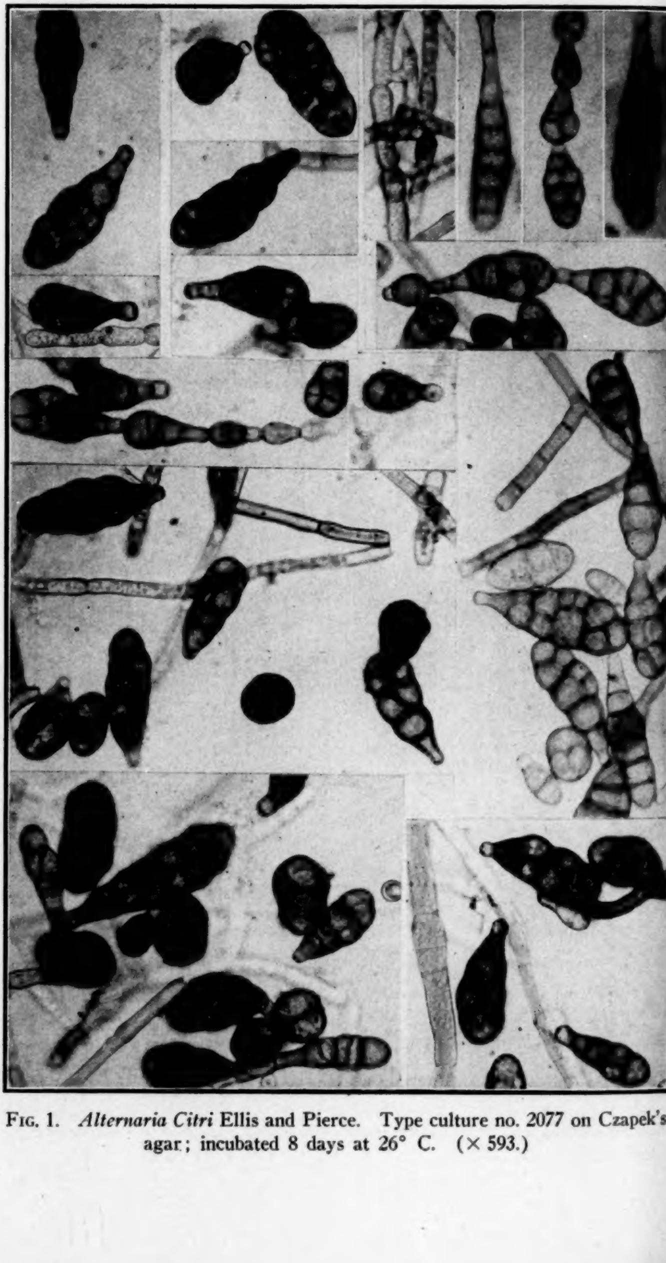


FIG. 1. *Alternaria Citri* Ellis and Pierce. Type culture no. 2077 on Czapek's agar; incubated 8 days at 26° C. (× 593.)

prepared from a neotype, specimens of which have been deposited in several herbaria. New evidence is presented on the morphology and taxonomy of *Alternaria Citri,* based on a statistical study of 26 isolates from fruit of Washington Navel orange, Deglet Noor date palm, and Holguin guava. The taxonomic relation of *A. Citri* to certain other short-beaked forms of the genus is also discussed.

METHODS

During January, February, and March, 1943, isolates of *Alternaria* and other fungi were taken from fruit of the Washington Navel orange (*Citrus sinensis* [L.] Osbeck), the Deglet Noor date palm (*Phoenix dactylifera* L.), and the Holguin guava (*Psidium guajava* L.). Among the isolates of these fungi were certain ones of similar appearance, which were selected for study because they resembled *A. Citri.* Several dissimilar isolates, from date, were reserved for further study.

Isolates from orange, nos. 2060, 2061, 2062, 2067, 2068, 2069, 2077, 2078, and 2081, were obtained at the University of California Citrus Experiment Station, Riverside, California; nos. 2063, 2064, and 2065, at North Whittier Heights, California; nos. 2070 and 2071, at Claremont, California; nos. 2072 and 2073, at Azusa, California; nos. 2074, 2075, and 2076, at Charter Oak, California; and nos. 2079 and 2080, at Altadena, California. Isolates from date, nos. B-709, B-714, B-717, and B-719, were obtained at Indio, California. The isolate from guava, no. B-740,[5] was obtained at Riverside, California. Spore measurements from these 26 isolates, taken between February 11 and May 21, 1943, form the basis of the present study.

The isolates of *Alternaria* were grown in petri dishes at 26° C., on 2 per cent Czapek's agar[6] (pH 5.12), 2 per cent corn-meal agar[7] (pH 5.8), and on sterile slices of the fruit of Washington Navel orange, Valencia orange, and Eureka lemon. The spores produced on the slices of citrus fruit were so similar that, in sum-

[5] Isolated by W. T. Horne.

[6] Czapek's agar: $MgSO_4 \cdot 7H_2O$, 0.5 gram; KH_2PO_4, 1.0 gram; KCl, 0.5 gram; $FeSo_4 \cdot 7H_2O$, 0.01 gram; $NaNO_3$, 2.0 grams; sucrose, 30 grams; agar, 20 grams; distilled water, 1 liter.

[7] Corn-meal agar: Bacto-Corn-Meal Agar, 22 grams (20 grams agar); distilled water, 1 liter.

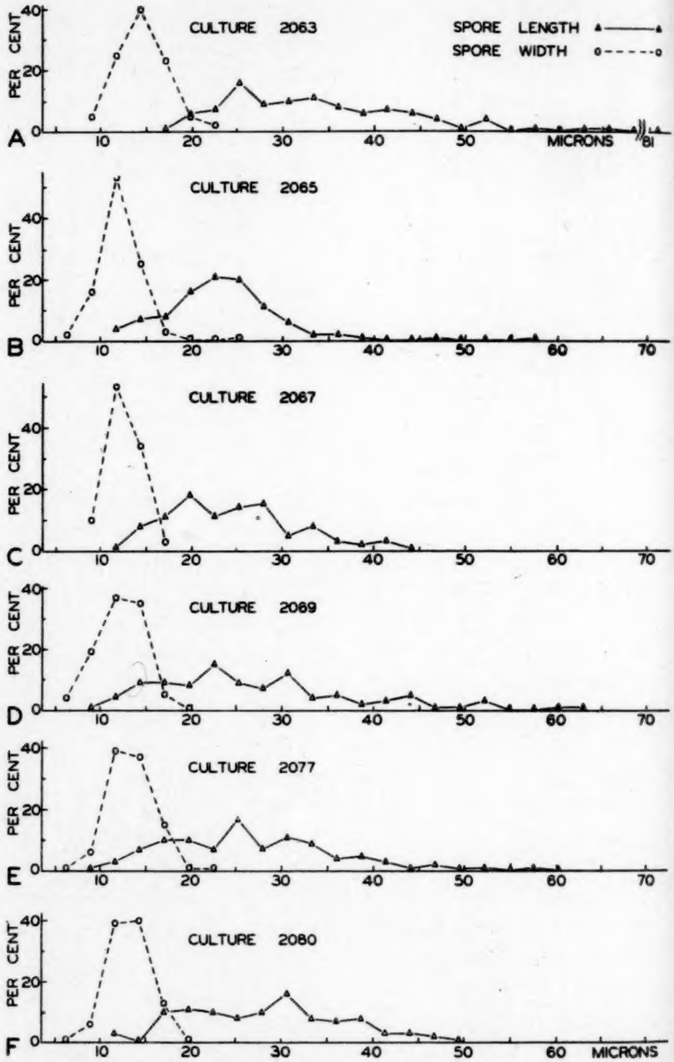


FIG. 2. *A–F,* curves showing percentage distribution of spores according to length and width, in six single-spore cultures of isolates of *Alternaria Citri* from Washington Navel orange. Each curve represents measurements of 100 spores taken at random.

marizing the morphological data, results from the citrus media were grouped together.

The fungus colony was examined after 7 to 20 days' growth by removing from the petri dish a disk of fungus-covered substrate, 4 mm. in diameter, and mounting it on a microscope slide without cover glass. The habit of growth and the number of spores in the spore chains were observed under low magnification. A small portion of the disk was then mounted in water with a cover glass. The slide was placed on a mechanical stage and moved backward and forward in such a manner as to bring only unexplored areas of the mount into the field of vision. A representative sample, including all the dark-colored, mature spores that entered the field, was used for measurement.[8] Transverse and longitudinal septations in these spores were noted, and spores with and without beaks were recorded on a dual counting device.

Three measurements were made of each spore, namely, the length (including the apical beak, if any), the width, and the length of the apical beak. The apical beaks were relatively short, bluntly pointed structures at the narrow, distal ends of the spores. They were hyaline or less deeply colored than the body of the spore. The length of the beak was measured along the longitudinal axis of the spore, from the apex to the edge of the nearest cell having a dark-brown protoplast (FIG. 5, *A*, *i*). Spores having either apical or lateral beaks were counted as "beaked spores," but only the apical beaks were included in the spore dimensions. Usually, the terminal spore was the only nonbeaked spore in a chain, although there were sometimes others. Beaked spores typically had a spore scar at the apex. Beaks having two or more spore scars usually had one or more transverse septa (FIG. 5, *A*, *c*, *l*).

The septation of recently matured spores was easily determined, but because of the tendency toward secondary cell division and excessive darkening in mature spores, the septation of some of the oldest spores was determined with difficulty. Only the cross walls *between* cells having brown protoplasts were counted as transverse

[8] All measurements were made under a fluorite oil-immersion objective, N. A. 1.32, and a 15 × ocular with eyepiece micrometer on which 1 graduation represented 0.90 μ. Measurements were read to the closest graduation of the micrometer.

septa. The outer walls of the colored cells in the terminal positions were not counted. In the development of the spore, a median transverse wall marked the first cell division, and other transverse walls were often laid down before the first longitudinal septum appeared. For this reason, the spore was considered to be divided into segments by the transverse septa. Each segment which contained one or more longitudinal walls was counted as having one longitudinal septum.

The number of spores in spore chains was determined principally because of interest in the maximum number, and the number most commonly developed. The relative size of spores in the same chain was also observed.

MORPHOLOGY

The percentage distribution of spores of *Alternaria Citri,* according to length (including beak), width, and length of apical beak, when cultured on the different media, is shown in table 1. In this table the scale of measurement is, for convenience, divided into units of 2.7 μ, or 3 graduations on the eyepiece micrometer, each.

The wide variation in the length of spores, when grown on Czapek's agar, is remarkable. Although 80 per cent of the spores from isolates from Washington Navel orange measured from 13.1 to 34.6 μ in length (a range of 21.5 μ), the other 20 per cent included the remainder of the scale, from 8.1 to 13.0 μ and from 34.7 to 81.0 μ. The length encountered most frequently was that between 23.9 and 26.5 μ, although only 14 per cent of the spore population was included in this class. In isolates from date, on Czapek's agar, 82.7 per cent of the spores measured between 13.1 and 34.6 μ in length, and the extremes were 9.9 and 57.6 μ, respectively. In this case, the length encountered most frequently was that between 21.2 and 23.8 μ, including only 12.8 per cent of the spore population—a group only slightly larger than five others. The width of spores grown on Czapek's agar was considerably more uniform than the length. In isolates from orange, 89.3 per cent of the spores were 7.7 to 15.7 μ wide, while in isolates from date, 94.8 per cent were in this range. Spores with long beaks were found occasionally, but at least 90 per cent of spores from the

TABLE 1

PERCENTAGE DISTRIBUTION OF SPORES OF ALTERNARIA CITRI, ACCORDING TO LENGTH, WIDTH, AND LENGTH OF BEAK, WHEN ISOLATED FROM VARIOUS FRUITS AND CULTURED ON DIFFERENT MEDIA

Culture medium, number of spores measured, and character of measurement	Percentage of spores according to measurement *																											
	0.0 to 2.2 (μ)	2.3 to 4.9 (μ)	5.0 to 7.6 (μ)	7.7 to 10.3 (μ)	10.4 to 13.0 (μ)	13.1 to 15.7 (μ)	15.8 to 18.4 (μ)	18.5 to 21.1 (μ)	21.2 to 23.8 (μ)	23.9 to 26.5 (μ)	26.6 to 29.2 (μ)	29.3 to 31.9 (μ)	32.0 to 34.6 (μ)	34.7 to 37.3 (μ)	37.4 to 40.0 (μ)	40.1 to 42.7 (μ)	42.8 to 45.4 (μ)	45.5 to 48.1 (μ)	48.2 to 50.8 (μ)	50.9 to 53.5 (μ)	53.6 to 56.2 (μ)	56.3 to 58.9 (μ)	59.0 to 61.6 (μ)	61.7 to 64.3 (μ)	64.4 to 67.0 (μ)	67.1 to 69.7 (μ)	80.6 to 83.2 (μ)	99.5 to 102.1 (μ)
21 isolates from fruit of Washington Navel orange																												
Czapek's agar—1000 spores:																												
Length †				0.4	2.1	5.6	9.3	12.2	11.7	14.0	10.9	9.6	6.7	4.8	3.1	3.1	2.4	1.3	0.7	0.9	0.1	0.4	0.1	0.2	0.2	0.1	0.1	
Width			2.6	22.1	39.5	27.7	7.0	0.7	0.3	0.1																		
Length of beak	39.9	36.3	14.5	4.7	1.5	1.2	0.5	0.1	0.2	0.4	0.4	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1							
Citrus fruit slices—174 spores:																												
Length †				0.6	14.4	25.9	25.3	14.4	3.5	10.3	1.7	0.0	1.7	0.0	0.6	0.0	0.6	0.6	0.0	0.0	0.0	0.0	0.6					
Width			5.7	44.3	38.5	11.5																						
Length of beak	66.2	17.8	8.1	2.9	1.2	1.2	0.0	0.6	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6											
Corn-meal agar—800 spores:																												
Length †					2.6	5.4	9.6	14.8	14.0	13.6	10.8	8.0	6.5	4.0	2.6	2.1	1.1	1.5	1.0	1.0	0.3	0.4	0.3	0.1	0.1	0.1	0.0	0.1
Width			8.0	48.5	39.6	3.5	0.4																					
Length of beak	13.8	59.9	22.0	3.0	1.0	0.1	0.3																					
4 isolates from fruit of Deglet Noor date palm																												
Czapek's agar—400 spores:																												
Length †				0.5	5.5	11.8	12.0	12.5	12.8	11.0	9.3	6.8	6.5	4.2	3.5	1.0	1.0	0.0	0.2	0.5	0.2	0.7						
Width			3.8	34.8	41.5	18.5	1.5																					
Length of beak	35.0	38.0	12.5	5.0	3.0	3.0	0.5	1.5	0.8	0.0	0.8																	
Citrus fruit slices—215 spores:																												
Length †				6.0	19.1	20.5	17.2	15.8	12.6	5.1	2.3	0.5	0.0	0.9														
Width			13.5	40.5	25.1	17.2	3.7																					
Length of beak	65.6	24.7	8.4	1.4																								
1 isolate from fruit of Holguin guava																												
Corn-meal agar—40 spores:																												
Length †						2.5	17.5	20.0	15.0	27.5	2.5	0.0	5.0	2.5	2.5	2.5	2.5											
Width			2.5	52.5	42.5	2.5																						
Length of beak	20.0	47.5	27.5	5.0																								

* For cenvenience, the scale was divided into units of 2.7 μ, each unit representing three graduations on the eyepiece micrometer. † Including beak, if any.

TABLE 2

PERCENTAGE DISTRIBUTION OF SPORES OF ALTERNARIA CITRI, ACCORDING TO NUMBER OF TRANSVERSE AND LONGITUDINAL SEPTATIONS, WHEN ISOLATED FROM VARIOUS FRUITS AND CULTURED ON DIFFERENT MEDIA

Culture medium	Number of spores examined	Percentage of spores having the given type and number of septa																		
		Transverse												Longitudinal						
		0	1	2	3	4	5	6	7	8	9	10	11	0	1	2	3	4	5	6
21 isolates from fruit of Washington Navel orange																				
Czapek's agar	1,400	0.4	12.9	17.4	51.5	9.4	4.9	2.3	0.5	0.5	0.1			15.8	22.0	35.9	20.7	5.1	0.5	0.1
Citrus fruit slices	174	0.6	46.5	26.4	22.4	2.3	0.0	1.2	0.0	0.6				28.7	35.1	32.2	4.0			
Corn-meal agar	800	0.1	9.8	23.9	40.9	13.5	6.8	3.5	1.1	0.3	0.1	0.1		23.6	28.5	31.8	15.1	0.9	0.1	
4 isolates from fruit of Deglet Noor date palm																				
Czapek's agar	800	0.3	22.1	21.4	40.6	7.6	5.3	1.5	0.5	0.3	0.3	0.0	0.3	19.1	31.0	34.6	13.3	1.5	0.5	
Citrus fruit slices	214	5.6	53.7	23.8	15.9	0.5	0.5							37.4	29.9	27.6	5.1			
1 isolate from fruit of Holguin guava																				
Corn-meal agar	40		7.5	42.5	40.0	5.0	2.5	2.5						10.0	27.5	47.5	15.0			

orange isolates and 85 per cent of those from date had either no beaks or beaks up to 7.6 μ in length.

The response of *Alternaria* on sterile fruit slices of Washington Navel orange, Valencia orange, and Eurkea lemon was very different from that on Czapek's agar. The fungus on citrus fruit slices produced much aerial mycelium with relatively few spores, while on Czapek's agar it produced little aerial mycelium with many significantly longer and broader spores. More than 90 per cent of the spores from orange and date isolates, when grown on sterile slices of citrus fruit, were from 10.4 to 26.5 μ, mostly 13.1 to 15.7 μ, in length (table 1). Only about one third of the spores were beaked, and these beaks were mostly less than 7.6 μ in length.

Abundant sporulation was obtained on corn-meal agar. Spores from these cultures were similar in length to those on Czapek's agar (table 1), but they were somewhat narrower, and their beaks had greater mean length.

Spores with 1 to 4 transverse septa were relatively common in all cultures; the extreme range of variation was from 0 to 11 septa (table 2). On Czapek's agar and on corn-meal agar, 40.6 to 51.5 per cent of the spores were 3-septate. About half of the spores from citrus fruit slices were 1-septate, however, and less than one fourth of them were 3-septate. Spores with 2 longitudinal septa were most common on the agar media, and spores with 1 or no longitudinal septum were most common on citrus fruit slices.

The number of spores in spore chains was easily observed in cultures on the agar media but not in cultures on citrus fruit slices, because of the aerial mycelium. The spore chains on corn-meal agar had noticeably more spores than those on Czapek's agar (table 3). Whereas 6-spored chains were most numerous on corn-meal agar, 4-spored chains were most numerous on the other. One chain of 17 spores was observed on corn-meal agar.

About 40,000 spores were examined for beaks (table 4). Of these spores, grown on the different media, the following percentages were beaked: on citrus fruit slices, 31.1 to 37.8 per cent; on Czapek's agar, 61.1 to 62.9 per cent; and on corn-meal agar, 84.9 to 87.5 per cent.

It was commonly observed that the length of individual spores in a chain tended to decrease more or less regularly from the oldest

TABLE 3

PERCENTAGE DISTRIBUTION OF SPORE CHAINS OF ALTERNARIA CITRI, ACCORDING TO NUMBER OF SPORES IN CHAINS, WHEN ISOLATED FROM VARIOUS FRUITS AND CULTURED ON DIFFERENT MEDIA

Culture medium	Number of spore chains examined	Percentage of spore chains having the given number of spores															
		Number of spores															
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
21 isolates from fruit of Washington Navel orange																	
Czapek's agar	903	0.5	16.2	25.4	23.5	15.1	10.7	5.5	2.0	0.9	0.2						
Corn-meal agar	680		0.3	4.0	13.0	20.4	19.7	15.9	10.9	7.8	4.7	2.4	0.3	0.3	0.0	0.0	0.2
4 isolates from fruit of Deglet Noor date palm																	
Czapek's agar	410	1.2	9.3	20.3	19.3	15.1	11.2	9.8	5.3	5.3	1.2	1.5	0.2	0.2			

TABLE 4

PERCENTAGES OF BEAKED SPORES IN CULTURES OF *Alternaria Citri*, FROM VARIOUS ISOLATES GROWN ON DIFFERENT MEDIA

Culture medium	Number of spores observed	Beaked spores	
		Number	Per cent
21 isolates from fruit of Washington Navel orange			
Czapek's agar	14,305	8,734	61.1
Citrus fruit slices	3,750	1,167	31.1
Corn-meal agar	11,755	10,294	87.5
4 isolates from fruit of Deglet Noor date palm			
Czapek's agar	6,074	3,820	62.9
Citrus fruit slices	4,439	1,681	37.8
1 isolate from fruit of Holguin guava			
Corn-meal agar	575	488	84.9

to the youngest—that is, from the proximal to the distal end of the chain. All the mature spores in 31 chains were measured. Although variations were observed in certain instances, the mean length of the spores, taken consecutively and beginning with the oldest in each chain, decreased in order from no. 1 to no. 8 (table 5). Irregularities in the results beyond this point are attributed to the small number of individuals measured.

Characters such as spore size and the tendency to produce beaks have been markedly influenced in these studies by the different kinds of nutrient media used. At first we thought that *Alternaria Citri* might respond most favorably when grown on fruit of the Washington Navel orange, but this was not the case. Slices of citrus fruit were poorly suited for culture media, because when grown on this fruit, the spores of the fungus were relatively small, thin-walled, nonbeaked, smooth, and light-colored, as compared with those grown on agar. Also, spore chains, on citrus fruit slices, were either absent or obscured by masses of aerial mycelium.

That *Alternaria Citri* was first described and named in relation to a disease of citrus is no reason why it should necessarily appear

TABLE 5

LENGTH OF CONSECUTIVE SPORES IN SPORE CHAINS OF ALTERNARIA CITRI *

Spore no.	Total number of spores measured	Spore length	
		Range (μ)	Mean (μ)
1	31	14.63–49.40	30.38
2	31	15.58–41.30	26.72
3	31	13.30–31.35	22.42
4	30	13.30–35.53	21.53
5	24	12.35–34.20	19.80
6	16	13.30–27.55	19.24
7	12	7.60–29.45	17.41
8	3	8.74–20.90	15.26
9	2	17.10–22.80	19.95
10	2	15.20–19.00	17.10
11	1		14.25
12	1		9.50

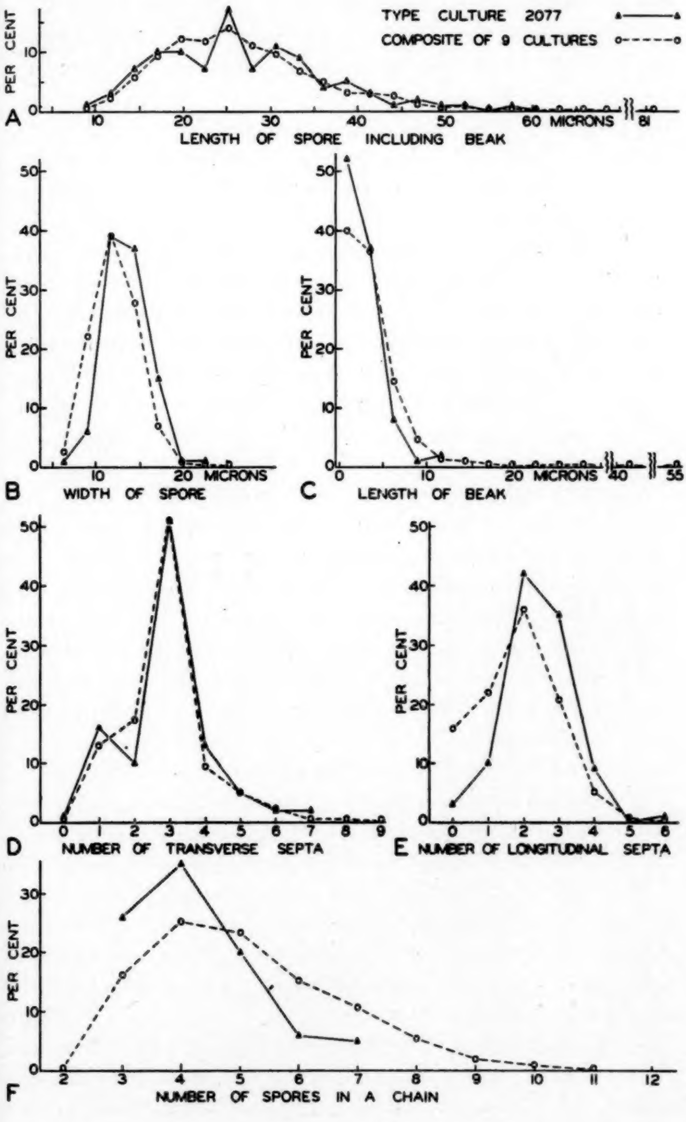
* All spores except the youngest or terminal spore in each of 31 spore chains were measured in order, from the proximal to the distal end of each chain.

most vigorous and natural while attacking citrus fruit. Furthermore, as found imbedded in the ripening flesh of the date, *A. Citri* is difficult to recognize except by the usual methods of isolation and culture. In the date, the mycelium is sterile and composed of greatly swollen cells, some of which are 30 μ in diameter. The appearance of isolates on agar *in vitro* is therefore the primary basis on which we have formed our concept of the species.

Apparently, Elliott (**12**) did not study *Alternaria Citri*, but he demonstrated, in seven other species of *Alternaria*, variations in spore size which were induced by different types of nutrient media. Elliott also observed that "slight changes in media may cause great changes in the submerged mycelium."

Such variations in growth response emphasize the need for a standard cultural environment and laboratory technique in connection with the description and identification of *Alternaria* spp. We have found Czapek's agar (see footnote 6) to be a favorable

FIG. 3. Percentage-distribution curves of type culture 2077 and of a composite of nine cultures of isolates 2060, 2061, 2062, 2063, 2065, 2067, 2069, 2077, and 2080 of *Alternaria Citri* from Washington Navel orange. *A*, length of spore, including beak; *B*, width of spore; *C*, length of beak; *D*, number of transverse septa; *E*, number of longitudinal septa; and *F*, number of spores in spore chains. Curves for culture 2077 represent measurements of 100 spores; those for the composite, 1,000 spores.


TYPE CULTURE 2077
COMPOSITE OF 9 CULTURES
PER CENT
A
LENGTH OF SPORE INCLUDING BEAK
10 20 30 40 50 60 MICRONS 81
B
WIDTH OF SPORE
10 20 MICRONS
C
LENGTH OF BEAK
0 10 20 MICRONS 40 55
D
NUMBER OF TRANSVERSE SEPTA
0 1 2 3 4 5 6 7 8 9
E
NUMBER OF LONGITUDINAL SEPTA
0 1 2 3 4 5 6
F
NUMBER OF SPORES IN A CHAIN
2 3 4 5 6 7 8 9 10 11 12

culture medium for the growth and sporulation of *A. Citri,* and because its definite chemical composition can be easily duplicated, we have used this medium in the preparation of our neotype material.

Cultures of *Alternaria Citri* often become sterile when grown for extended periods on the common laboratory media. At first an isolate may sporulate profusely and have little aerial mycelium. After repeated subculturing, however, the tendency toward sterility will be marked by a gradual reduction in the length of the spore chains, an increase in the number of large, single, irregularly shaped conidia, and the development of much aerial mycelium. Devitalized cultures of this kind are atypical and should not be included in morphological studies. For these reasons the related strains of *Alternaria* may be best identified when freshly isolated cultures are grown and observed under standard laboratory conditions.

Our isolates of *Alternaria Citri* have shown considerable variation in the length of spore chains and in the tendency of the chains to branch when grown on different media. Since most of the spores within a chain are beaked, while the terminal spore is not, the percentage of beaked spores is relatively higher in cultures having long, straight spore chains than in those having short spore chains or chains in which there is much secondary branching.

It has been shown that the spores in a chain tend to decrease in length from oldest to youngest. This is perhaps due to the relative availability of food at different points along the spore chain. In this acropetal type of sporulation, the first or oldest spore grows directly from the conidiophore; but the second spore, at the apex of the first, must obtain its food by translocation through cells of the first spore. Similarly, food for succeeding spores must pass through all the older spores in the chain, a process that naturally becomes more difficult at each step. Very long spore chains may have several short, swollen cells (one-celled spores) near the distal end (FIG. 5, *J*). These diminutive spores may darken and have small beaks, but normal enlargement does not occur. A similar effect on spore size may also result from the branching of the spore chain. Smaller spores develop after the food stream has been divided.

Wakefield (**37**) suggested an interesting but somewhat ques-

tionable theory regarding the length distribution curve for conidia of *Alternaria Brassicae* var. *Citri*. The curve for the conidia, which varied in length from 9 to 44 μ, was complex and was thought to represent a composite curve consisting of a series of smaller, overlapping and interesting curves. Wakefield suggested that each of the smaller curves may possibly correspond to a conidium of fixed position with reference to the conidiophore and in relation to the other conidia in the chain.

The primitive nature of *Alternaria Citri* within the *Alternaria-Stemphylium* group is suggested by the morphological similarity between the spores and the mycelium (FIG. 1). A spore of this species resembles a segment of the mycelium containing one or more cells. Such a "segment" is hyaline and slender at first but becomes darkened and more or less swollen with age. Secondary cell division may also occur in this "segment." The cells of this "segment" are reasonably uniform in size, although the number may vary considerably. Each cell may germinate separately and may therefore be regarded as a potential spore and equivalent to any hyphal cell in the asexual propagation of the fungus.

A spore chain of *Alternaria Citri* resembles a branch of the mycelium. Division and elongation of cells occur near the distal end, where a principal axis of growth predominates. Branching may occur along the sides of this "mycelial branch." Certain long, slender spores, such as that shown in figure 5, *C*, are little more than extension joints in the conidiophore. All that distinguishes them from the conidiophore is a slight swelling, a somewhat darker color, and the ability to break apart from other segments in the chain. We regard *A. Citri* as a primitive fungus—one that is so little specialized in form that it cannot be sharply defined.

An *Alternaria*-like fungus was cultured by the junior author from *Phoenix dactylifera*, at Golea, Algeria, January 30, 1934. Wiltshire, who identified the organism as *Alternaria hispida* (Harz) Oudemans 1902, states, in correspondence: "It is not a true *Alternaria* as the spores do not separate from each other nor from the conidiophore and is probably the same fungus as *Phoma conidiogena* Schnegg 1915." [9] Thus we see a morphological similarity between members of two widely separated form genera.

[9] Wiltshire, S. P. Letter to H. S. Fawcett. June 7, 1935.

The principal difference, except for the so-called *Phoma* stage, is the ability of the spores to break apart.

In the present study, the similarity between certain isolates from citrus, date, and guava indicate that *Alternaria Citri* may have a rather wide, indefinite range. In selecting a type to represent our concept of the species, however, we considered only single-spore cultures from isolates from fruit of Washington Navel orange. Curves of frequency distribution, based on measurements of 100 spores each, were prepared to illustrate the amount of variability encountered. The curves for spore length were remarkably broad and flat, whereas those for width were comparatively steep (FIG. 2).

Nine single-spore cultures from isolates nos. 2060, 2061, 2062, 2063, 2065, 2067, 2069, 2077, and 2080, were selected to represent the range of variations observed in *Alternaria Citri*. Composite curves constructed from the combined data of these nine cultures were compared with the corresponding curves of the separate cultures. The composite curves agreed most perfectly with those of culture 2077, from Riverside, California. Culture 2077 was therefore judged to be the most representative member of the group and was selected to typify our concept of the species (FIG. 3).

The graphic illustrations of spore measurements, septations, and catenulation, shown in figure 3, give a quantitative picture of variations in *Alternaria Citri*, not only for our type culture but also for the group of cultures from which our type was selected. These curves (FIG. 3) may be of value in identifying other isolates under conditions of similar laboratory technique.

To test our technique, subcultures of culture 2077 were grown on freshly prepared Czapek's agar for 20 days at 26° C. Measurements of a random sample of 100 spores gave distribution curves for length, width, length of beak, and for numbers of transverse and longitudinal septa that were essentially similar to those of the original measurements (FIG. 3). The spore chains in these later cultures, however, were longer than those previously observed: they ranged from 3 to 10 spores per chain, the largest class (27 per cent) containing 7 spores. Differences in age may have caused this discrepancy, for spore chains in the original cultures were examined when the cultures were 10 to 14 days old, while the later ones were examined after 20 days. As a diagnostic char-

acter, the number of spores in a chain may therefore be less reliable than spore size and septation.

EMENDED DESCRIPTION OF SPECIES

The original specific characterization of *Alternaria Citri,* accredited to Ellis and Pierce and published by Pierce (**26**), was as follows:

> "**Alternaria citri, n. sp.**—In oranges in California. Effused, olivaceous, becoming nearly black. Mycelium abundant, loosely interwoven, gray, consisting of slender, septate, yellowish or olivaceous-hyaline threads, penetrating and overrunning the matrix, much branched, the branches mostly a little swollen at the apex and bearing the terminal variously shaped conidia, which are obovate, oblong-elliptical or subglobose at first, 10–22 × 8–15 μ diam., and mostly 3-septate, finally large, 25–40 × 15–25 μ, short-clavate-oblong, 4–6-septate and slightly constricted at the septa, the cells divided by one or more longitudinal septa, dark olive-brown. The conidia are oftener 3–6-catenulate in series, either simple or branched. As shown by cultures, secondary conidia often arise directly from the primary, thus giving rise to a secondary series. The cells of the conidia at maturity incline to assume a spherical shape, and the conidia then resemble somewhat asci filled with globose sporidia."

From its habitat, inside the orange, and the character of the conidia, Pierce (**26**) concluded that *Alternaria Citri* was distinct from *A. tenuis* Nees on orange leaves. No type specimens were mentioned by Pierce and none have been found in the Ellis Herbarium. Recently, a photographic copy of Pierce's unpublished original illustrations(the only ones known to exist) of the black rot of oranges and the spores of *Alternaria Citri* (FIG. 4) was graciously loaned to the writers by Mrs. Newton B. Pierce, of Santa Ana, California.[10]

The emended description follows:

[10] An unpublished manuscript entitled "Black Rot of Navel Oranges," by Newton B. Pierce, was also loaned by Mrs. Pierce. A typewritten copy of this manuscript, probably written during the period 1893–1901, is on file in the Library of the University of California Citrus Experiment Station, Riverside, California. The paper deals principally with economic and pathological phases of the subject.

Alternaria Citri Ellis & Pierce em.

Coloniae in agaro Czapekii effusae, griseae, olivaceo-brunneae vel atrae, in adversum obscurae; myceliis septatis, ramosis, 2.7–6 μ in diam., primum hyalinis et tenuibus, demum brunnescentibus et inflatis; conidiophoris simplicibus ramosisve, septatis, tenuibus, ad apices non inflatis, 3–5 μ in diam., olivaceo-brunneis, hilis terminalibus et interdum lateralibus praeditis; conidiis acropetalis, 2–7-catenulatis vel solitariis, pallidis usque olivaceo-brunneis, vetustis obscurescentibus, glabris vel verrucosis, plerumque obclavatis vel ovoideis, rostratis vel erostratis, muriformibus, septis transversis 0–7 (plerumque 2–4), longitudinalibus 0–6 (plerumque 1–4), magnitudine variis, rostro apicali incluso 8–60 μ (plerumque 10–37 μ) longis, 6–24 μ (plerumque 8–16 μ), latis; rostris plerumque 0–8 μ longis, hyalinis vel pallide brunneis, hilo apicali praeditis; catenulis sporarum simplicibus vel ramosis, rectis.

Hab. in fructibus *Citri sinensis* (L.) Osbeck, Riverside, California.

Colony on Czapek's agar rapid growing, effused, somewhat zonate, gray, olive-brown to dull black; reverse dark gray, purplish or brownish black; outline irregular. Mycelium septate, branched, 2.7–6 μ in diameter, at first hyaline and slender, becoming brownish and swollen (FIG. 5, *G, H*). Conidiophores simple or branched, septate, slender, not swollen at apex, 3–5 μ in diameter, olive-brown, with terminal and sometimes lateral spore scars (FIG. 5, *C–F*). Conidia acropetal, 2–7-catenulate or solitary, light to olive-brown, darkening with age, smooth to verrucose, variously shaped, mostly obclavate or oval, beaked apically or laterally, or nonbeaked, slightly restricted at the septa, muriform, with 0–7 (mostly 2–4) transverse and 0–6 (mostly 1–4) longitudinal septa, size variable, length (including apical beak) 8–60 μ (mostly 10–37 μ), breadth 6–24 μ (mostly 8–16 μ); beaks mostly 0–8 μ long, blunt or rounded, 0–3-septate, hyaline or light brown, with spore scare at apex (FIG. 5, *A, B*). Spore chains simple or branched, erect, arising from or near apex of conidiophores or directly from conidia (FIG. 5, C, *H–J*).

Habitat: Fruit of Washington Navel orange, *Citrus sinensis* (L.) Osbeck, Riverside, California.

Neotype specimens on which the emended description is based, grown on Czapek's agar, have been deposited in the Mycological Collections of the Bureau of Plant Industry, Beltsville, Maryland. Coneotypes are deposited in herbaria, as follows: University of California, Berkeley, California; University of California Citrus Experiment Station, Riverside, California; Florida Agricultural Experiment Station, Gainesville, Florida; New York Botanical Garden, Bronx Park, New York City; Imperial Mycological Insti-

tute, Kew, Surrey, England; Plant Pathological Division, Instituto Biologico, São Paulo, Brazil; and Department of Agriculture, Pretoria, Union of South Africa.

The principal differences between the original and the emended descriptions of *Alternaria Citri* may be attributed to the effect of different substrates on the development of this fungus. The spores illustrated by Pierce (FIG. 4) resemble spores that we have seen on flesh of decayed citrus fruits. Most of the spores shown in figure 4 (several of which had germinated) were probably taken from fruit, because a penciled notation (by Pierce) specifies that a chain of four conidia near the upper right-hand corner of the plate are "culture spores." This, together with inferences in the written description, suggest that, although Pierce's concept of the species was based largely on the condition *on* and *within* the fruit, he studied the fungus both in the orange and in artificial culture. That secondary conidia and spore chains are best demonstrated in cultures has also been our experience.

The relative importance of a slight apical swelling in the conidiophores of *Alternaria Citri* is a matter of opinion. Some conidiophores are "a little swollen at the apex," as indicated in the original description, although the emended description does not mention this fact. We have stressed the unswollen conidiophore of *Alternaria Citri* because it is typical of the species, and also because it represents one of the cardinal points of distinction between *Alternaria* and *Stemphylium,* as defined by Wiltshire (**38**, **39**).

In the original description, Pierce (**26**) states that conidia of *Alternaria Citri* are at first relatively small ($10–22 \times 8–15\ \mu$) but finally become large ($25–40 \times 15–25\ \mu$). This would indicate that only the larger spores are mature. If one may judge, however, from the dark color of many small spores in cultures where growth has ceased, and from the ability of these spores to germinate, it would seem that the conidia may reach morphological and physiological maturity throughout a much wider range of sizes. The emended description defines this range as $8–60 \times 6–24\ \mu$.

TAXONOMY

We are indebted to Mason (**19**) and Wiltshire (**38**, **39**) for their studies of the early literature and source material of *Alternaria*

Nees, *Macrosporium* Fries, and *Stemphylium* Wallroth. Much of this literature and material was not available to us.

Wiltshire (**38**), after studying the available specimens and discussing the basis for the names *Alternaria* and *Macrosporium*, concluded that, except for species having sarciniform spores, such as

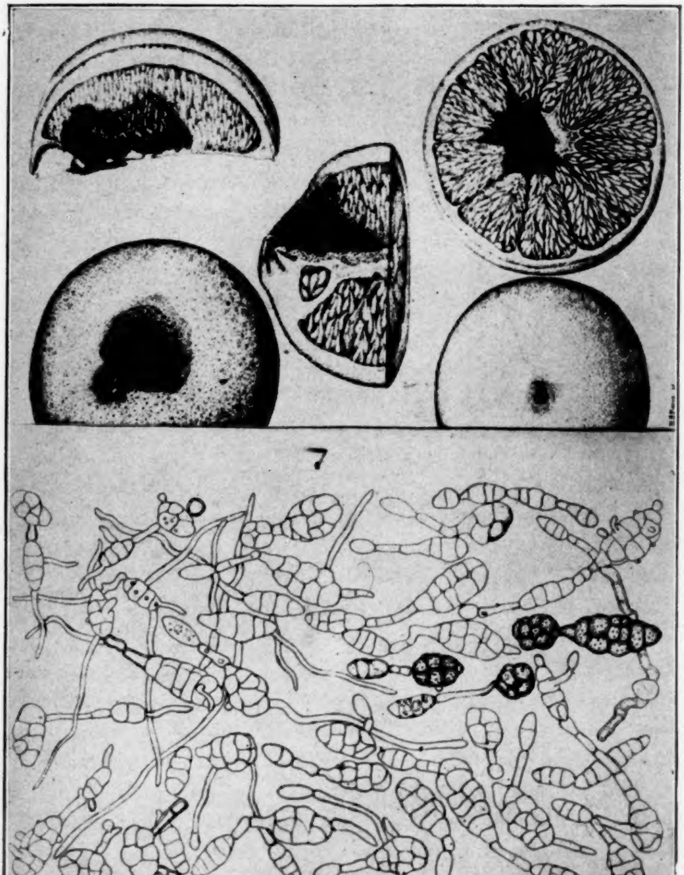


FIG. 4. Photographic copy of two hitherto unpublished, original illustrations by Newton B. Pierce. Above, fruits of Washington Navel orange showing symptoms of black rot; below, spores of *Alternaria Citri*.

Macrosporium sarciniforme Cavr., the name *Alternaria* should be used for most of the species now called *Alternaria* and *Macrosporium,* and that *Macrosporium* should be placed in the list of *nomina ambigua.* *A. tenuis* Nees was considered the type for the genus *Alternaria.*

Later, Wiltshire (**39**) studied specimens of *Stemphylium botrysum,* by Wallroth, who founded the genus *Stemphylium* in 1833, and concluded that this fungus was the same as that known in the literature later as *Macrosporium sarcinula* Berk., the conidial stage of *Pleospora herbarum* (Pers.) Rab. He concluded that these forms of *Macrosporium* constitute the true *Stemphylium* of Wallroth. Wiltshire thus put part of *Macrosporium* into *Alternaria* and part into *Stemphylium.* The characters which distinguish *Stemphylium* from *Alternaria,* as thus understood by Wiltshire, are (1) conidiophores swollen at the apex, (2) growth of the conidiophores continued through the terminal scar, and (3) an oval, subangular spore "frequently constricted at the major median transverse wall and never beaked."

The fungus considered in the present paper is one of the forms that fall in the group commonly known as *Alternaria,* and is similar in general to the modern concept of *A. tenuis,* but apparently not to that illustrated by Nees. It is characterized by conidiophores that are not swollen at the apex and by beaked spores that are frequently borne in chains.

Since 1923, *Alternaria Citri,* or a very similar species, has been identified in California more than 160 times. The isolates, originating from fruit rots and spots on leaves and fruit in several localities in the state and from various species and varieties of *Citrus,* have been roughly identified by their character of growth in culture. This fungus has also been isolated many times in California from date palm (*Phoenix dactylifera* L.) and less frequently from avocado (*Persea gratissima* Gaertn.), guava (*Psidium Guajava* L.), and from *Cneoridium* sp.

Spores similar to those of *Alternaria Citri* have been identified in 24 collections from *Citrus,* represented by specimens in the herbarium of the University of California Citrus Experiment Station. Among these are specimens from 16 localities in California, and others from Phoenix, Arizona; Palermo, Sicily; Monzel bon zelf,

Tunis; Damietta, Egypt; the Televiv region of Palestine; from Asuncion, Paraguay; and from Montevideo, Uruguay. Similar types of spores have been noted in photomicrographs sent by Dr. S. P. Wiltshire, from citrus specimens originating in Portugal, Cyprus, Southern Rhodesia, and the Union of South Africa; they have also been noted in isolates from citrus taken in Florida, Italy, Egypt, and Australia.

Relatively large variations in spore size were found in the individual cultures and specimens studied. In general, these variations were of similar magnitude. In comparing the fungus in one culture or specimen with that in another culture or specimen, there seemed to be no natural grouping that would suggest differences in specific rank. Differences have often been noted in the development of mycelium and in the degree of sporulation, but these have not remained constant in culture. Differences in such unstable characters have been regarded as insufficient cause for the separation of species. In correspondence, Wiltshire [11] has pointed out that some isolates appear to have a larger percentage of long-beaked spores than others and that this feature might serve to separate certain types. It is our observation that spores in certain cultures may show all gradations between no beaks and moderately long beaks. Since, in our experiments, the type of media has greatly influenced the percentage of beaked spores, and even the average length of the beaks, it would seem unwise to separate different strains of *Alternaria* on the basis of this character unless the fungi are compared under uniform conditions. Because of the wide variations in size and shape of spores in any specimen, the fungus should be cultured and subjected to considerable study before any separation is attempted.

The following species of fungi are now considered by us to be similar to *Alternaria Citri*. The first of these (*Stemphylium Citri*) is probably identical; the others are similar but not certainly the same.

Stemphylium Citri was described in 1910 by Patterson and Charles (**22**), from end rot of oranges in Arizona. Examination and spore measurements of the fungus on microscope slides loaned by the United States Department of Agriculture, Bureau of Plant

[11] Wiltshire, S. P. Letter to H. S. Fawcett. June 7, 1935.

Industry, show that it is indistinguishable from *Alternaria Citri*. This fungus is not a true *Stemphylium* as understood by Wiltshire (**39**), because the conidiophores are not swollen at the apex and the spores are beaked.

Macrosporium Citri was described in 1899 by McAlpine (**20**) on leaves of lemon in South Australia. In addition to the description and figures published by McAlpine, we have examined only a photograph of drawings by Wiltshire of a few spores from the type specimen. In size and septation, the spores of this fungus are reasonably similar to those of *Alternaria Citri*, but the spore body appears thicker and the beak more slender. *M. Citri* apparently belongs in the genus *Alternaria*, but the question of its identity with *A. Citri* Ellis and Pierce must await further study.

There is a remarkable similarity between *Alternaria Mali* Roberts and *A. Citri*, if we may judge from the published description and illustrations (*29*). *A. Mali* is reported by Roberts (**29**) to be "found constantly associated with characteristic spots on apple leaves from Virginia, Maryland, Tennessee, Arkansas, and Missouri." Doidge (**11**) states that "*A. Mali* is similar in morphology to *A. tenuis* and *A. Citri*." She investigated the pathogenicity of *A. Mali*, *A. tenuis*, and various strains of *A. Citri* on apple, cherry, and citrus leaves, and on citrus fruits. Certain minor physiological differences were noted, but all strains produced decay in citrus fruits.

Strains attributed to *Alternaria tenuis* Nees, reported on figs from California and Virginia by Brooks and McColloch (**6**), also bear a strong resemblance to *A. Citri*.

Important details in the original concept of *Alternaria tenuis* are obscure, since there is no mention of spore dimensions in the description published by Nees in 1817 (**21**). Nees's figure, reproduced by Wiltshire (**38**), shows chains of 2 to 4 spores, with filiform connections (beaks) that are approximately the same length as the spore bodies. Other illustrations of *A. tenuis* by Corda (**10**), Saccardo (**32**), Penzig (**23**), Berlese (**4**), Elliott (**12**), and Bolle (**5**), also reproduced and discussed by Wiltshire (**38**), indicate that the concept of this species has varied considerably from that of Nees. In one of the more recent concepts, such as that represented by Penzig (**24**) on citrus leaves, the spores are small

and close together in chains, with very short or no beaks. On the basis that *A. fasciculata* (Cooke & Ellis) Jones & Grout is a synonym of *A. tenuis* as studied by Bolle (**5**), Mason (**19**) referred to *A. tenuis* specimens "whose spores are obclavate, borne in long chains, and the majority of whose spores have 3 to 5 cross-septa, and, especially in culture, fall within the limits 20 to 50 × 10 to 14 μ." Among the species referred to *A. tenuis* or the *A. tenuis* group by Mason (**19**) are *A. Mali*, and *Macrosporium Citri*. Wiltshire (**38**) states that "the group of fungi which has in recent years come to be known as *A. tenuis*" should, in his opinion, be indicated as *A. 'tenuis'* auct., thus indicating that the name is not valid but that a better name is not available at present. In the course of time the specific limits of the different forms included in the group may be better understood and until this has been done the suggestion made seems the most practical under the circumstances."

In correspondence, Shear has suggested that "since there seems to be no type or authentic material of *A. tenuis*, it would be desirable to select a specimen from some other source to designate as the neotype. In this case we find that Saccardo issued in his exsiccati *Mycotheca veneta No. 297* what he considers to be this species. Since this is a well known series of specimens and is accessible in most large herbaria and is the basis of modern interpretations it would seem that it would be quite proper to designate this as the neotype." [12]

Spores of the above-mentioned specimen attributed to *Alternaria tenuis* Nees by Saccardo were mounted on a microscope slide and loaned to us through the courtesy of Mr. J. A. Stevenson, of the United States Department of Agriculture. Among 530 spores examined, 79 per cent were beaked; of these, many were imperfect, the apex of the beak having been broken. Nearly all the spores were shriveled somewhat, and the length of the beak was not easily determined because the color of the spores had apparently faded.

In comparing spores from our isolates of *Alternaria Citri* with those from the Saccardo specimen of *A. tenuis* (table 6), we found noticeable differences in the mean lengths, with and without beaks, and in the mean lengths of beaks alone. That spores of *A. Citri*

[12] Shear, C. L. Letter to H. S. Fawcett. October 28, 1943.

TABLE 6

SPORE DIMENSIONS OF *Alternaria Citri* * AND *A. tenuis* † COMPARED

Spore measurement	*A. Citri* (μ)	*A. tenuis* (μ)
Length:		
Range, with beak	8.1–81.0	10.3–56.2
Range, with beak (86.9 per cent of population) ‡	10.4–37.3	21.2–45.4
Mean, with beak	26.9	32.9
Mean, without beak	23.3	27.0
Mean, beak alone §	5.5	8.6
Width:		
Range	6.3–24.3	7.2–14.4
Range (89.3 per cent of population) ‡	7.7–15.7	7.7–13.0
Mean	12.2	11.2

* Based on measurements of 1000 spores from isolates from Washington Navel orange on Czapek's agar.

† Based on measurements of 100 spores of *A. tenuis* Nees from Saccardo's exsiccati *Mycotheca veneta* No. *297*. *Leguminibus putrescentibus* "*Lathyri latifolii*" [*Lathyrus latifolius L.*] September, 1874, Selva (Treviso), Italy. (Loaned by U. S. Dept. of Agriculture.)

‡ Smallest and largest measurements omitted from the range of total population.

§ This calculation includes beaked spores only.

had a greater range of length may be attributed in part to the larger number of measurements made for this species. It seemed significant, however, that when 13.1 per cent of the spore population (that portion of the population including the shortest and longest spores) was omitted, the range of spore lengths, with beaks, was 10.4–37.3 μ for *A. Citri* and 21.2–45.4 μ for Saccardo's specimen of *A. tenuis*.

Alternaria tenuis, as represented by the Saccardo specimen, does not seem to correspond either with the original figure and description of Nees (**21**) or with the more recent concepts of Elliott (**12**) and Bolle (**5**). The range of spore sizes indicated by our measurements of the Saccardo specimen agrees rather closely with that indicated for *A. tenuis* by Mason (**19**), but neither agrees with that of *A. Citri* as we have studied it. If the Saccardo specimen were to be designated the neotype for *A. tenuis* Nees, we should assume that it was from the same host plant and from the same general locality as the original material. Since these assumptions would probably be false, and since the spores of the Saccardo specimen differ noticeably in shape from those figured by Nees

(21), we are not inclined to consider the Saccardo specimen as the neotype of *A. tenuis* Nees.

It seems to us that the real *Alternaria tenuis*, if it can be determined, should have beaks averaging about the same length as

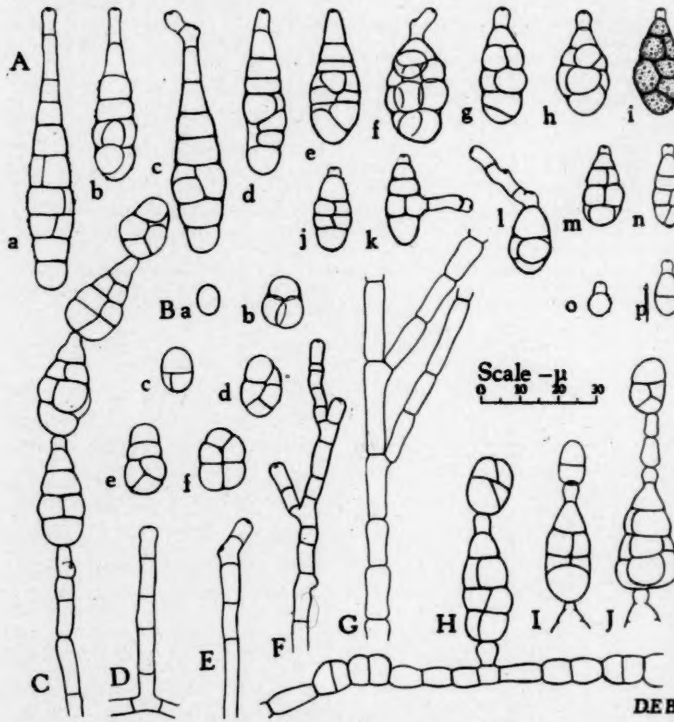


FIG. 5. *Alternaria Citri.* *A, a–p,* spores with beaks; *B, a–f,* spores without beaks; *C,* conidiophore with spore chain; *D–F,* conidiophores; *G,* young mycelium; *H,* old mycelium with spores attached; *I,* apex of spore chain showing formation of young conidium; *J,* apex of spore chain showing two short, swollen cells (spores) near the distal end. (All × 000.)

the spore body rather than the nonbeaked or short-beaked form now attributed to it. Although the spores of *A. Citri,* as we have observed them, are characterized by short beaks and no beaks, the percentage of beaked spores and the average length varying somewhat with the type of medium, the question arises as to whether

some of the specimens identified as *A. tenuis* Nees in recent years may not be good representatives of *A. Citri*.

Wiltshire, in correspondence, states that "'*A. tenuis* auct.' has been consistently interpreted by Elliott, Bolle and others as a species which rarely if ever has a definite beak. The name is well established in the literature in this sense but as it is applied to a fungus different from that Nees had, it will be necessary to give '*A. tenuis* auct.' a new name unless it can be shown to have another earlier valid name." [13]

Elliott (**12**) tentatively divides the species of *Alternaria* and *Macrosporium* into six groups "of similar forms which may be identical, and which are undoubtedly closely allied." He suggests that "these groups might well be retained to indicate the similarity of a number of forms such as is exemplified in bacteriology in the B. [*Bacterium*] *coli* and *B.* [*Bacillus*] *subtilis* groups," and that each group "should be designated by a typical species." Elliott's *A. tenuis* group is characterized by spores ranging in size from $11\text{–}50 \times 7\text{–}20\ \mu$, not including the beaks. According to his observations, "the spores are quite variable in form as well as in size but are generally broad and muriform." He lists 37 and possibly 46 species in this group. *A. Citri* is not listed but it would also belong here.

Young (**40**) produced 165 "new diseases" by means of cross-inoculations with species of *Alternaria* and *Macrosporium*, under laboratory and greenhouse conditions. The production of disease symptoms on hosts not previously recorded, indicated that many species of these genera are facultative parasites with wide experimental host ranges.

In a compilation of the species of *Alternaria* and *Macrosporium* included in Saccardo's *Sylloge Fungorum*, Young (**41**) lists more than 100 species with spore dimensions falling within the extreme range of sizes here attributed to *A. Citri*. Although spore dimensions are not the only important characters on which these species are separated, it is evident that much synonymy exists.

We have shown that *Alternaria Citri* has short-beaked or non-beaked spores representing a relatively wide range of sizes. The emended description includes several closely related species which

[13] Wiltshire, S. P. Letter to D. E. Bliss. January 25, 1944.

have wide geographic distribution and host range. The name *A. tenuis,* although no longer valid, has in recent years been applied to a group of fungi which resemble *A. Citri* more than they resemble the original description and illustration of *A. tenuis* Nees. While retaining *A. tenuis* as the type species of the genus, it seems desirable, until a comprehensive survey of the genus is made, to regroup the small-spored, short-beaked forms about some other representative species such as *A. Citri.*

SUMMARY AND CONCLUSIONS

The fungus *Alternaria Citri,* described in 1902 by Pierce and accredited to Ellis and Pierce, is widely distributed throughout the temperate and subtropical zones but is apparently unknown in the tropics. Confusion regarding the morphological limits of this species has arisen because type specimens and illustrative material are lacking.

New evidence on the morphology and taxonomy of *Alternaria Citri* is presented. This evidence is based on a statistical study of spores and other characters of 26 isolates from fruit of Washington Navel orange, Deglet Noor date palm, and Holguin guava, from various localities in southern California, including some of those localities where Pierce obtained his specimens.

A method, using Czapek's agar, is proposed as a standard laboratory technique for the comparison of isolates and the identification of *Alternaria Citri.* Citrus fruit slices were conducive to the production of much mycelium and relatively few spores; corn-meal agar and Czapek's agar favored abundant sporulation with but little aerial mycelium. Marked differences developed when transfers of the same isolate were cultured on different media. Much similarity was found, however, between various isolates (including those from orange, date, and guava) when cultured under uniform conditions on the same medium.

Measurements of 2629 spores in the present study showed wide ranges of variation, especially in length. Isolates from citrus fruit, on Czapek's agar, produced spores 8.1–81.0 μ in length, including beaks (86.9 per cent of the spores measuring 10.4–37.3 μ), and 6.3–24.3 μ in width (89.3 per cent of the spores measuring 7.7–

15.7 μ). The beaks of these spores were up to 54.0 μ in length (90.7 per cent, up to 7.6 μ). Spores cultured on corn-meal agar were similar in length but somewhat narrower, with longer beaks. The same isolates on citrus fruit slices gave spores, 93.8 per cent of which were only 10.4–26.5 μ long.

The number of transverse septa in the spores examined ranged from 0 to 11 and were commonly 1 to 4. On Czpek's agar, 40.6 to 51.5 per cent of the spores had 3 transverse septa, but on citrus fruit slices less than 25 per cent had 3 septa and approximately 50 per cent were 1-septate. Among 40,000 spores grown on the different media, the following percentages were beaked: on citrus fruit slices, 31.1 to 37.8 per cent; on Czapek's agar, 61.1 to 62.9 per cent; and on corn-meal agar, 84.9 to 87.5 per cent. The percentages of beaked spores were higher in cultures having long, straight spore chains than in cultures having short or branched spore chains. Terminal spores were mostly nonbeaked; the others were mostly beaked. In general, the average length of the spores in the chains decreased in order from the oldest to the youngest, that is, from the proximal to the distal ends of the chains. This decrease in length may be due to the decreasing availability of food at the distal end of the chain as it lengthens. The spore chains on corn-meal agar were noticeably longer than those on Czapek's agar.

The primitive nature of *Alternaria Citri* within the *Alternaria-Stemphylium* group is suggested by the morphological similarity between the spores and the mycelium. Graphic illustrations of spore dimensions, septation, and catenulation, give a quantitative picture of variations in the species, which may be of value in identifying other isolates.

The principal differences between our emended description of *Alternaria Citri* Ellis and Pierce and the original descriptions, and between our illustrations and those of Pierce's, may be attributed to the effect of different substrates on the development of the fungus. Pierce's concept was based largely on the condition of the fungus *within or on the orange fruit;* ours, on the appearance *in culture.* The fungus may best be identified when freshly isolated cultures are observed under standard conditions.

The fungus considered here is a true *Alternaria,* similar to the modern conception of *A. tenuis* Nees, but not to the conception

suggested by the original illustration of Nees's. Examination of a large number of isolates and herbarium specimens of *A. Citri* has revealed relatively large variations in spore size within the individual cultures and specimens. These variations have, in general, been of similar magnitude. No natural grouping that would suggest differences in specific rank has been noted. Since the type of medium used is found to influence markedly the percentage of beaked spores and the average length of the beaks, any separation of different strains on these characters should be based on comparison under uniform conditions.

Other species of fungi now considered by us to be similar to *Alternaria Citri* are the following: *Stemphylium Citri* Patterson and Charles (probably identical with *A. Citri*), *Macrosporium Citri* McAlpine, *A. Mali* Roberts, and *A. tenuis* Nees as reported on figs by Brooks and McColloch (**6**). The real *A. tenuis,* if it can be determined, should have beaks averaging about the same length as the spore body, rather than the nonbeaked or short-beaked form now attributed to it. The name *A. tenuis,* although no longer valid, has in recent years been applied to a group of fungi which resemble *A. Citri* more than they resemble the original description and illustration of *A. tenuis* by Nees. While retaining *A. tenuis* Nees as the type species of the genus, we suggest that the short-spored, short-beaked species be tentatively grouped about some other species such as *A. Citri.*

ACKNOWLEDGMENTS

Sincere appreciation is expressed to Mrs. Newton B. Pierce for her permission to use unpublished illustrations and to examine an unpublished manuscript by the late Mr. Newton B. Pierce; to Dr. C. L. Shear, Mr. J. A. Stevenson, and Dr. Anna E. Jenkins for helpful advice and the loan of specimens; to Miss Edith K. Cash for the preparation of Latin description; to Dr. S. P. Wiltshire for his constructive criticism of the text; and to Miss Elizabeth Parker for assistance in summarizing the data.

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ADDITIONS TO THE UREDINALES OF VENEZUELA—IV[1]

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Our studies of the rusts of Venezuela began more than ten years ago. After determining about 1000 collections which were fairly well identified as to hosts, there remained a considerable residue (perhaps 125 collections) in which the hosts were either doubtfully or not identified. Many of these specimens were so sterile or so fragmentary that hope for much aid in host identification seemed improbable.

Many of these specimens bore well developed rusts and looked so interesting that we were loath to give up their further study and investigation. We determined to see what progress we might make by combining our knowledge of rust and host characters. Most every specimen we examined presented the aspect of a "puzzle" but we nevertheless decided to see what we might accomplish through what may be called "circumstantial evidence."

Sometimes we began with a clue from the rust. For example, if the teliospores had two cells, bilaminate walls, and pedicels with appendages, we recognized these as character of the genus *Prospodium*. This genus is known to inhabit the families Verbenaceae and Bignoniaceae. With this start we could begin checking both rust and host with known species and specimens.

The host characters which could be checked were chiefly details of leaf structure pertaining to shape, texture, venation, glands, hairs, and margins. Sometimes we guessed that a host might belong to a certain family. We would then familiarize ourselves with the rusts reported on that family and see whether our rust

[1] Contribution from the Department of Botany, The Pennsylvania State College, No. 143. Publication authorized April 12, 1944, as paper No. 1231 in the Journal Series of The Pennsylvania Agricultural Experiment Station. Previous papers in this series are as follows: Monog. Univ. Puerto Rico B. **2**: 262–303, 1934; Mycologia **30**: 537–552, 1938; **35**: 434–445, 1943; **36**: 54–64, 1944.

might be one of them. Many times that procedure brought results. Occasionally we had fortunate accidents. By this we mean that when we were comparing our specimen with a known specimen we found it did not agree but we came to the realization that another one would.

As our studies proceeded we were confident that we were making some "hits." Later we found out that we had made some "near misses." The facts are that we have solved a considerable number of the "puzzles" and the point is that some of our most interesting "additions" to the rust-flora of Venezuela have come out of this residue, which at first seemed so hopeless. The conclusion is that mycological collectors must not fail to take specimens even if the host is sterile and the specimen must be fragmentary. It should not encourage them, however, to be careless or lacking in persistence to get the very best material available. We cannot overemphasize the value of notes about the host. Even such elementary facts as the type of plant—whether shrub, tree or vine—and whether the leaves are simple or compound, alternate or opposite, etc., may turn out to be the "circumstantial evidence" that will lead to a solution.

This report adds 30 species to the Venezuelan rust list. In our first paper published in 1934 the total was given as 184; two errors have reduced this to 182. Our additions in 1938 brought the total to 204, in 1943 to 237, in 1944 to 262, and now to 292.

We must add that after carrying our studies as far as possible we sought the aid of several phanerogamic botanists. They have verified many of our identifications, have put us right on others, and have made some additional difficult determinations. To say that they have rendered valuable assistance is an under-statement. Without their help we could not have reduced the residue to the mere handful as is now the case. Our thanks are due to Dr. E. P. Killip, Dr. S. F. Blake, Dr. P. C. Standley, Dr. H. A. Gleason, Dr. H. K. Svenson, and Dr. R. E. Woodson. We are again indebted to Professor R. E. Dengler, of The Pennsylvania State College, for aid in the preparation of the latin diagnoses of the 12 new species.

Aecidium Coutareae sp. nov.

Pycnidiis amphigenis, in greges parvos maculis decoloratis insidentibus, profunde insitis, oblate globosis, 80–95 × 96–144 μ; periphysibus 40–55 μ longis.

Aecidiis hypophyllis in maculis decoloratis insidentibus, in annulos 2–5 mm. diam. circum pycnidia aggregatis, breviter cupulatis, 0.1–0.2 mm. diam.; peridio albido, margine eroso, aliquantum recurvato; cellulis peridii rhomboideis, 16–20 × 29–35 μ; tunica exteriore 6–7 u cr., interiore 3–4 μ, verrucosa; aecidiosporis late ellipsoideis, 16–23 × 21–29 μ; tunica incolori, ca. 1.5 μ, minute aequaliterque verrucosa.

On *Coutarea hexandra* (Jacq.) Schum. In Chapparal, near El Sombrero, Est. Guarico, July 20, 1940, *C. E. Chardon 4044*.

This host belongs to the family Rubiaceae. A number of aecia have been described on various genera of this family but our specimen does not match any species with which we have made comparisons.

Aecidium Hymemocallidis sp. nov.

Pycnidiis amphigenis, in greges parvos maculis decoloratis insidentibus, inconspicuis, subepidermalibus, oblate globosis, 100–130 μ latis; periphysibus fasciculum 50–65 μ longum efformantibus.

Aecidiis amphigenis, numerosis, in maculis decoloratis insidentibus, in greges orbiculares vel ellipticos 5–10 mm. diam. circum pycnidia aggregatis, cupulatis, parvis, 0.1–0.2 mm. diam.; peridio albido, margine recurvato, lacerato; cellulis peridii imbricatis, e facie polygonis, 16–21 × 23–32, probabiliter longioribus; tunica exteriore striata ad 6 μ cr., interiore ca. 3 μ, verrucosa; aecidiosporis late ellipsoideis, 16–19 × 19–26 μ; tunica incolori, ca. 1.5 μ cr., minute crebreque verrucosa.

On *Hymemocallis* aff. *caribaea* Herb. El Valle, Caracas, Dist. Federal, May 20, 1941, *Fr. Fernandez Yepez 4000 A*.

Jackson (Mycologia **18**: 154–155. 1926.) reports from Chile two species of *Aecidium* on the family Amaryllidaceae, both on *Alstromeria*. One of these has aeciospores with colored walls and is obviously different. The other is also different in having broader and taller aecial cups. There is a species on *Zephyranthes* from Mexico which differs from our specimen in the character of the peridial cells and in the pycnia.

ANGIOPSORA LENTICULARIS Mains, Mycologia **26**: 127. 1934.

On *Lasiacis procerrima* (Hack.) Hitchc. Forests at Rancho Grande, Est. Aragua, April 30, 1938, *C. E. Chardon 2629;* Rancho Grande, road Maracay a Ocumare de la Costa, Est. Aragua, March

28, 1939, *Chardon* & *Whetzel 3185;* road Maracay a Choroni, Est. Aragua, April 9, 1939, *Chardon, Whetzel* & *Müller 3388.*

The type specimen of this species is from Ecuador. It has also been reported from Puerto Rico. In the original description Dr. Mains states that the pores of the urediniospores are inconspicuous. While that is true we have made them out to be 6–8, scattered. This arrangement holds for the specimens from Ecuador and Puerto Rico and ours from Venezuela agree. *Uromyces costaricensis* Sydow on *Lasiacis* species has 2–4 equatorial pores. This fact enables one to make determinations with assurance even when only urediniospores are present as in the case of our Venezuelan specimens.

Bubakia venezuelana sp. nov.

Pycnidiis plerumque epiphyllis, inconspicuis, gregariis, in maculis decoloratis insidentibus, subcuticularibus, oblate hemisphericis vel conicis, 48–58 μ longis, ca. 112 μ latis.

Uredosoris amphigenis, sparsis, in maculis decoloratis dispositis, ca. 0.5 mm. diam., mox nudis, cinnamomeo-brunneis, pulvervulentis, epidermide rupta non visibili; uredosporis late ellipsoideis vel obovoideis, 16–23 × 26–34 μ; tunica flavo-brunnea, 1.5–2 μ cr., subinde ad apicem incrassata 3–5 μ, sparse prominenterque aculeata; poris obscuris.

Teleutosoris ignotis.

On *Croton* sp. Road to Chirgua, Est. Carabobo, March 8, 1939, *Whetzel* & *Müller 2951.*

Although the telia are unknown, the pycnial and uredinial characters are such that the relationship to the genus *Bubakia* seems unquestionable. In that genus, subcuticular pycnia have been reported by Jackson (Mycologia **23**: 466. 1931.) and by Cummins (Mycologia **32**: 370. 1940.). The aecia of the genus are uredinoid, subepidermal, and without peridium or paraphyses. In our material we are unable to separate aecia (primary uredinia) and secondary uredinia. There are four other species of *Bubakia* described on *Croton.* From the three species of the western hemisphere, *B. Crotonis, B. argentinensis,* and *B. mexicana,* our species differs in the combinations of urediniospore characters, especially in markings on the walls. It is sparsely and strongly aculeate as against echinulations in the others. The African species, *B. stratosus,* has coarse markings but the walls of the spores are much thicker and the spores are larger.

ENDOPHYLLOIDES PORTORICENSIS Whetzel & Olive; Olive & Whetzel, Am. Jour. Bot., **4**: 51. 1917.

On *Mikania* sp. Ocumare de la Costa, Est. Aragua, March 19, 1938, *C. E. Chardon 2488;* Rancho Grande, road Maracay a Ocumare de la Costa, Est. Aragua, March 25, 1939, *Chardon & Whetzel 3138.*

The specimens here cited presented a difficult problem when we began our studies. The rust has the appearance of old aecia and the host was unnamed. Preliminay examination revealed that the rust was not an *Aecidium.* We thought the host of one specimen might be a species of *Eupatorium.* Further studies showed the absence of pycnia and the presence of short waxy columns of spores in sunken cups, surrounded by a peridium made up of verrucose cells. This led to the suggestion that the rust might be *Pucciniosira Eupatorii* Lagerh. Our specimen was so old that it was difficult to determine the nature of the spores. They were germinated and so collapsed that we could not make out whether or not they were two-celled. Later, through the aid of Dr. S. F. Blake, the hosts were identified as a species of *Mikania.* This fact, together with the probability that the spores are one-celled, led to the determination of our specimens as *Endophylloides portoricensis.* All of the other characters agree with that species. The species has been reported from the West Indies, Central America, and Colombia.

Melampsora Euphorbiae-geniculatae sp. nov.

Pycnidiis hypophyllis, gregariis, numerosis, in maculis decoloratis insidentibus, punctiformibus, dein nigro-brunneis, subcuticularibus, oblate hemisphericis vel truncatis, prominentibus, 33–55 μ longis, 48–87 μ latis; periphysibus nullis.

Aecidiis hypophyllis, in maculis decoloratis insidentibus, confluentibus in annulum unum 1–3 mm. diam., flavescentibus, epidermide bullata diu tectis, tandem plus minusve late apertis, dein pulverulentis, epidermide rupta conspicua; aecidiosporis catenulatis, globosis vel late ellipsoideis, 13–16 × 18–23 μ; tunica pallide flava vel hyalina, ca. 1 μ cr., minute aequaliterque verrucosa.

Uredosoris et teleutosoris ignotis.

On *Euphorbia geniculata* Ortega. Banks of Neveri, near Barcelona, Est. Anzoategui, May 26, 1938, *C. E. Chardon 2673.*

There are seven species of *Melampsora* described on the genus *Euphorbia*. Of these, three species have aecial stages known and are autoecious. It seems likely that the other four species are also autoecious. None of the species of *Melampsora* on *Euphorbia* have ever been reported from South America. It is possible that our species here described may be identical with one of the species known elsewhere on *Euphorbia,* but that does not seem probable.

Phakopsora antiguensis (Cummins) comb. nov.

Uredo antiguensis Cummins, Bull. Torrey Club **67**: 613. 1940.

On *Acalypha* sp. Road Petare-Guarenas, Est. Miranda, March 15, 1939, *Whetzel* & *Müller 2972.*

Uredo antiguensis was described from Guatemala. Dr. Cummins pointed out that the species would perhaps be found to belong in the genus *Phakopsora.* Our specimen from Venezuela has abundant telia. In the Guatemalan specimen the uredinia are grouped whereas in the Venezuelan specimen they are scattered. We believe that two specimens represent the same species. A description of the telia follows:

Telia hypophyllous, subepidermal, indehiscent, surrounding the uredinia, united into a crust 2–3 spores high; teliospores cuboid or oblong, 10–13 × 15–26 µ; wall 1.5 µ thick, somewhat thicker in the apical spores, cinnamon-brown, the lower cells paler, sessile.

Phakopsora Randiae sp. nov.

Pycnidiis et aecidiis ignotis.

Uredosoris hypophyllis, sparsis, rotundatis, parvis, punctiformibus, 0.1–0.2 mm. diam., flavis, subepidermalibus; paraphysibus sorum circumdantibus, numerosis, plus minusve clavatis, 7–13 × 29–42 µ, hyalinis; tunica convexo latere 3–4 µ incrassata; uredosporis subglobosis vel obovoideis, 16–21 × 19–26 µ; tunica hyalina, 1–1.5 µ cr., moderate echinulata; poris obscuris.

Teleutosporis hypophyllis, sparsis vel laxe gregatis, in maculis flavis subinde uredosoros circumdantibus, rotundatis vel irregularibus, 0.1–0.5 mm. diam., saepe confluentibus, epidermide tectis, nigro-brunneis; teleutosporis 2–6 superpositis, oblongis, cubicis vel plus minusve ellipsoideis, 10–15 × 16–32 µ; tunica 1–1.5 µ cr., superioribus ad apicem crassioribus, 3–7 µ, castaneo-brunneis, inferioribus pallidioribus.

On *Randia armata* (Sw.) DC. Túcupe, near Caracas, Dist. Federal, Feb. 28, 1939, *Whetzel* & *Müller 2842; Randia caracasana* Standl. Túcupe, near Caracas, Dist. Federal, Feb. 28, 1939, *Whetzel* & *Müller 2852.*

The punctiform uredinia opening by a central pore are typical. The dark telia are well developed, numerous, and fairly conspicuous. The telia may develop independently and are often separated from the uredinia.

Prospodium araguatum sp. nov.

Pycnidiis et aecidiis ignotis.

Uredosoris hypophyllis, sparsis, in maculis decoloratis insidentibus, cinnamomeo-brunneis, rotundatis vel irregularibus, 0.3–0.5 mm. diam., subepidermalibus, epidermide rupta conspicua; uredosporis asymmetricis, globosis vel late ellipsoides, 26–35 × 29–35 µ, vel ellipsoideis, 19–22 × 20–35 µ; tunica bilaminata, interiore cinnamomeo-brunnea, 2.5–3.5 µ cr., exteriore hyalina tumescente et valide aculeata, 3–5 µ, supra poros 2 aequatoriales deficiente.

Teleutosoris hypophyllis, sparsis vel in greges parvos in maculis decoloratis dispositis, cacao-brunneis, ellipticis vel irregularibus, subinde confluentibus; 0.3–0.7 mm. diam., epidermide rupta conspicua; teleutosporis late ellipsoideis, 27–32 × 37–43 µ, ad septum non constrictis; tunica bilaminata, 2.5–3.5 µ cr., interiore castaneo-brunnea, exteriore brunneola, moderate papillato-echinulata; poro cellulae superioris apicali, poro cellulae inferioris ad pedicelli insertionem sito, utroque poro unbone hyalino tecto; pedicello sporam aequante vel dimidio superante, hyalino, in tertia parte inferiore appendicibus 2–4 ramosis et verticillatis praedito.

On Bignoniaceae (*Tabebuia?*). Road Maracay a Guigue, Est. Aragua, April 5, 1939, *Chardon, Whetzel* & *Müller 3327*.

The specimen consists of two large leaves, or leaflets. The host is, therefore, unidentifiable but it seems likely to belong to Bignoniaceae, possibly a species of *Tabebuia*. The rust obviously belongs to the section *Euprospodium* of the genus *Prospodium*. The combination of characters differs from any of the species in Cummin's monograph (Lloydia **3**: 1–78. 1940.).

Prospodium Cumminsii sp. nov.

Pycnidiis epiphyllis, rubro- vel aurato-brunneis, subcuticularibus, lentiformibus vel conicis, 90–115 µ altis, 185–265 µ latis, periphysibus praeditis.

Aecidiis amphigenis vel plerumque hypophyllis, in greges 130–350 µ diam. dispositis, plus minusve confluentibus, flavo-brunneis, apparenter subcuticularibus, uredinoideis; paraphysibus paucis vel carentibus; aecidiosporis late ellipsoideis vel globoideis, 22–27 × 25–29 µ; tunica flavida vel aurato-brunnea, 2.5–3 µ cr., aculeata, spinis 2.5–3.5 µ longis; poris 2, aequatorialibus, utroque poro umbone humiliter cuticulari tecto.

Uredosoris non visis, probabiliter teleutosoris conformibus; uredosporis probabiliter aecidiosporis conformibus.

Teleutosoris hypophyllis, sparsis, aecidiis propinquis, flavido-brunneis, per stomata erumpentibus, cyathiformibus, 38–55 µ diam., 53–65 µ altis; stipite subhyalino; peridio aurato- vel cinnamomeo-brunneo, paraphysibus

periphericis, incurvatis, peridio concolorato, 7–9 × 36–43 μ, plerumque ad apicem acuminatis; tunica convexo latere 1.5–2 μ cr., concavo 2–3.5 μ, ad apicem 3–7 μ; teleutosporis ellipsoideis, 23–25 × 34–38 μ, supra et infra rotundatis, ad septum constrictis; tunica cinnamomeo- vel pallide castaneo-brunnea, 1–1.5 μ cr., levi; poro cellulae superioris apicali, cellulae inferioris ad pedicelli insertionem sito, utroque poro umbone humiliter cuticulari tecto; pedicello persistenti, flavido vel pallide aurato-brunneo, cylindraceo, inornato, 7–10 μ lato, longissimo, usque ad 350 μ longo, tunica crassa; teleutosporis maturis statim germinantibus.

On *Amphilophium paniculatum* var. *molle* (S. & C.) Standl. El Junquito, road to Colonia Tovar, Est. Miranda, July 24, 1938, *C. E. Chardon 2747 bis.*

In 1940 Dr. G. B. Cummins published a splendid monograph of the genus *Prospodium* (Lloydia **3**: 1–78.). This specimen was submitted to him and we are indebted to him for notes and measurements upon which the diagnosis is based. He has also supplied drawings and a photograph. As a tribute to his contribution to the knowledge of the genus and because of his aid in characterizing this species, we are pleased to dedicate the species to Dr. Cummins.

The species belongs to the section *Cyathopsora* and is unique and distinct, particularly in the very long teliospore pedicels which are without appendages.

It is interesting that this is the same collection (No. *2747*) upon which *Prospodium depallens* is being reported. The host appears very similar to other mycological collections determined as *Pithecoctenium echinatum.* Our collection has been determined as *Amphilophium paniculatum* var. *molle* by Dr. E. P. Killip.

PROSPODIUM DEPALLENS (Arth. & Holw.) Cummins, Lloydia **3**: 62. 1940.

On *Amphilophium paniculatum* var. *molle* (S. & C.) Standl. El Junquito, road to Colonia Tovar, Est. Miranda, July 24, 1938, *C. E. Chardon 2747.*

A most interesting microcylic species; pycnia are present and the teliospores are germinated. The oblique septum and the presence of a hyaline plug over the germ-pores are conspicuous characters. There are no appendages on the pedicles but Cummins refers the species to *Prospodium* because of the presence of basal cells in the telia. The species is heretofore known only from Costa Rica and Guatemala.

This specimen has been examined by Dr. E. P. Killip, who determined the host as here recorded. It resembles and is closely related to *Pithecoctenium echinatum,* on which this rust has heretofore been reported.

PUCCINIA AEGOPOGONIS Arth. & Holw.; Arth., Am. Jour. Bot. **5**: 467. 1918.

On *Eupatorium iresinoides* H.B.K. El Encantado, Est. Miranda, Aug. 6, 1937, *G. Vivas-Berthier 2756.*

This specimen differs from the description of the aecia of *Puccinia Aegopogonis* somewhat in habit and also in having aeciospore-walls frequently considerably thicker above. There must be some doubt whether this specimen really belongs here. The telial stage is on *Aegopogon* and is known to occur in Guatemala, Bolivia, and Ecuador. The aecia are otherwise known only from Guatemala.

Puccinia Chaetii sp. nov.

Uredosoris (amphisoris) amphigenis, sparsis, oblongis, 0.2–0.8 mm. longis, obscure cinnamomeo-brunneis vel castaneo-brunneis, epidermide rupta conspicua; amphisporis globosis vel late ellipsoideis, 26–29 × 29–35 μ; tunica cinnamomeo- vel pallide castaneo-brunnea, 2.5–3 μ cr., minute echinulata; poris plerumque 3, interdum leniter subaequatorialibus; pedicello plerumque persistenti, hyalino, sporam aequante vel breviore. Uredosporis immixtis, paucis, late ellipsoides, 17–23 × 23–29 μ; tunica pallide cinnamomeo-brunnea, 1–1.5 μ cr., echinulata; poris 3, aequatorialibus vel subaequatorialibus.

Teleutosoris amphigenis, sparsis, 0.3–1 mm., longis, atris, epidermide diu tectis; teleutosporis oblongo-ellipsoideis vel oblongo-clavatis, subinde angularibus, 18–26 × 39–44 μ, plerumque supra late rotundatis, infra contractis, ad septum leniter constrictis; tunica fragili, 1–1.5 μ, ad apicem leniter incrassata, pallide cinnamomeo-brunnea, infra pallidiore, levi; pedicello flavido, brevi, subinde oblique inserto.

On *Chaetium festucoides* Nees. El Sombrero, Est. Guarico, Dec. 5, 1939, *C. E. Chardon 3885.*

We have not found any rust on the tribe Paniceae like this. It is perhaps nearest to *Puccinia dolosa* Arth. & Fromme. A good description of the latter has been given by Dr. Cummins in Mycologia **34**: 681. 1942. Our species differs in having slightly larger teliospores and in the urediniospores which are globoid or obovoid and not triangular as in *P. dolosa.* The dominant urediniospores in the new species are without doubt amphispores, which are char-

acterized by thick walls and pores which are definitely subequatorial. Sometimes one pore is near the septum.

PUCCINIA CLAVIFORMIS Lagerh., Tromsö Mus. Aarch **17**: 53. 1917.

On *Solanum* sp. Road Maracay a Guigue, Est. Aragua, March 31, 1939, *Whetzel, Müller* & *Chardon 3252*.

Previously reported from Colombia and Panama.

PUCCINIA EUPATORII-COLUMBIANI Mayor, Mem. Soc. Neuch. Sci. Nat. **5**: 514. 1913.

On *Eupatorium* sp. Rancho Grande, Road Maracay, Est. Aragua, March 25, 1939, *Chardon* & *Whetzel 3119*.

Heretofore reported from Colombia, Brazil, Bolivia, and Trinidad.

PUCCINIA GLUMARUM (Schmidt) Erikss. & Henn., Zeits. Pflanzenkr. **4**: 197. 1894.

On *Triticum aestivum* L. Mucuchies, Est. Merida, Nov. 6, 1940, *N. Castillo* & *A. S. Müller 3932*.

Puccinia Hilleriae sp. nov.

Pycnidiis amphigenis, paucis, in areis hypertrophicis insidentibus, subepidermalibus, profunde insitis, atro-brunneis, ellipsoideis, 96–144 μ latis, 144–180 μ altis; periphysibus non visis.

Aecidiis amphigenis, in greges crebres 0.5–3 mm. dispositis plerumque areas hypertrophicas ad nervos efficientibus, flavidis, bullatis, 0.2–0.3 mm., poro apertis; peridio nullo; aecidiosporis ellipsoideis vel ellipsoideo-obovoideis, 18–23 × 34–42 μ, catenulatis; tunica pallide flavida vel subhyalina, ca. 2 μ cr., saepe supra et infra usque ad 5 μ incrassata, conspicue et sparse echinulata; poris obscuris, verisimiliter 1 vel 2 aequatorialibus.

Teleutosoris amphigenis, sparis vel interdum gregariis, rotundatis vel irregularibus, interdum punctiformibus, 0.1–0.2 m. diam., mox nudis, castaneobrunneis, pulverulentis, epidermide rupta conspicua; teleutosporis late ellipsoideis, 21–26 × 30–42 μ, supra et infra rotundatis, vix vel non constrictis; tunica castaneo-brunnea, 1.5–2 μ, apice non incrassata, moderate verrucosa; poro cellulae superioris apicali vel leniter laterali, inferioris laterali; pedicello fragili, hyalino.

On *Hilleria secunda* (R. & P.) H. Walt. Road La Guaira a Caracas, March 3, 1939, *Müller* & *Whetzel 2929*.

This species presents an interesting combination of characters. Pycnia, aecia, and telia are present. The telia fit the well estab-

lished genus *Puccinia.* The aecia are unusual in being without a peridium but with aeciospores which are catenulate and with echinulate markings on the walls. There are species lacking a peridium with catenulate spores but usually the markings are verrucose. When aeciospores are echinulate they are usually borne singly on pedicels. We are indebted to Dr. Cummins for calling attention to *Puccinia morobensis* described by him on *Tabernaemontana* from New Guinea. This has somewhat similar characteristics in that the aecia are without peridium and the aeciospores have walls which are not verrucose but aculeate. There may be other species with these exceptional characters but they appear to be rare.

[2] PUCCINIA HOLWAYULA Jackson, Mycologia **24**: 163. 1932.

Further study of specimens referred to this species, and to *Puccinia Oyedaeae* Mayor, in an earlier paper (Monog. Univ. Puerto Rico, Ser. B. No. 2, Uredinales, p. 280 and p. 284, 1934), reveals additional facts which should be reported. In the first place we now feel sure that the specimen, *Sydow 28,* on *Oyedaea verbesinoides* referred doubtfully to *Puccinia Oyedaeae,* is not that species at all but rather *Puccinia Holwayula.* We are now agreed that *Puccinia Oyedaeae* is not known from Venezuela. Since it was described from Colombia, there is reason to think that it may occur in Venezuela, but we have not yet found any specimens of it among those we have studied. In the second place we reported *Puccinia Holwayula* doubtfully on *Wedelia Jacquini caracasana* (D.C.) *O. F. Schultz, Chardon, Toro* & *Alamo 308* and *Chardon* & *Toro 455.* We are convinced that the hosts of these two collections are a species of *Oyedaea,* probably *O. verbesinoides.* We now have two additional specimens from Venezuela which we are referring to this species, both undoubtedly on *O. verbesinoides,* collected Caracas a Colonia Tovar, Dist. Federal, March 17, 1939, *Whetzel* & *Müller 2994* and *3002.*

Puccinia Holwayula is characterized by epiphyllous aecia, aeciospores with verrucose-tuberculate walls, and thick-walled urediniospores with coarsely verrucose-echinulate walls and scattered pores.

[2] This species is not an addition to the Venezuelan list; it was reported in 1934.

PUCCINIA HYPTIDIS (Curt.) Tracy & Earle, Bull. Miss. Exp. Sta. **34**: 86. 1895.

On *Hyptis capitata* Jacq. Rancho Grande, Road Maracay a Ocumare de la Costa, Est. Aragua, March 28, 1939, *Whetzel* & *Chardon 3187*.

Known from southeastern United States, West Indies, Trinidad, Colombia, British Guiana, and Bolivia.

PUCCINIA IMPEDITA Mains & Holw.; Arth., Mycologia **10**: 135. 1918.

On *Salvia* aff. *coccinea* Juss. Paramo La Negra, Est. Tachira, Nov. 17, 1939, *Barrus* & *Müller 3591*.

This species is well known in the West Indies and Central America. Jackson (Mycologia **24**: 76. 1932.) has reported it from Bolivia. It is also known in Trinidad.

Puccinia Mirandensis sp. nov.

Uredosoris hypophyllis, sparsis, ellipticis vel oblongis, 0.2–0.5 mm. longis, epidermide diu tectis, cinamomeo-brunneis; uredosporis ellipsoideis vel obovoideis, 19–26 × 29–35 μ; tunica flavida vel pallide cinnamomeo-brunnea, 1–1.5 μ cr., moderate echinulata; poris 3 aequatorialibus.

Teleutosoris hypophyllis, sparis, ellipticis vel oblongis, 0.2–0.7 mm. longis, nigrescentibus, tarde nudis, epidermide rupta conspicua; teleutosporis cylindraceis vel clavatis, 12–21 × 55–87 μ, supra rotundatis vel obtusis vel truncatis, infra contractis, vix vel non constrictis; tunica pallide castaneo-brunnea vel infra pallidiore, ca. 1.5 μ cr., apice incrassata, 5–10 μ, levi; pedicello tincto, brevi, 12–16 μ longo.

On *Scleria secans* Urban. Road Petare a Santa Lucia, Est. Miranda, April 13, 1939, *Whetzel* & *Müller 3400*.

There are two species of *Puccinia* known on *Scleria, Puccinia Scleriae* (Paz.) Arth. and *Puccinia scleriicola* Arth. Our species differs from both of these in the larger size of the spores, both urediniospores and teliospores. It differs further from *Puccinia Scleriae* in not having biseptate teliospores.

PUCCINIA OFFUSCATA Arth., Bull. Torrey Club **47**: 469. 1920.

On *Zornia diphylla* (L.) Pers. San Cristobal, Est. Tachira, Nov. 15, 1939, *Barrus* & *Müller 3599*.

Previously known from Florida, the West Indies, Brazil, and Bolivia.

PUCCINIA SOLANI-TRISTIS P. Henn., Hedwigia **35**: 236. 1896.

On *Solanum* sp. Highway, Hacienda Moron, Est. Carabobo, April 3, 1939, *Whetzel, Müller* & *Chardon 3310.*

This microcylic species is characterized by comparatively small teliospores with fairly thin yellowish or colorless walls. It has heretofore been reported only from Brazil.

RAVENELIA INDICA Berk., Gard. Chron. **1853**: 132. 1853.

On *Cassia Absus* L. El Tigre, Est. Anzoategui, Sept. 29, 1939, *A. S. Müller 3487.*

Previously known from India, Mexico, and Cuba.

UREDO ALCHORNEAE P. Henn., Hedwigia **35**: 252. 1896.

On *Alchornea triplinervia* (Spreng.) Muell. Arg. Caracas a Colonia Tovar, Dist. Federal, March 19, 1939, *Whetzel, Müller,* & *Tamayo 3046.*

Our rust agrees perfectly with the description given by Sydow (Monog. Ured. **4**: 457. 1924.) which is based on a specimen from Tubarao, Prov. St. Catherina Brazil. So far as known to us this is the first report outside the type locality.

UREDO ERYTHRINAE P. Henn., Ann. Mus. du Congo **2**: 224. 1908.

On *Erythrina* glauca Willd. Gorge Road, Maracay a Guigue, Est. Aragua, March 31, 1939, *Chardon, Whetzel* & *Müller 3238.*

This species was originally described from the Congo. It has since been reported from Ceylon, the Philippines, Guatemala, and Ecuador. It is characterized by the small sori, numerous paraphyses, and small colorless spores.

Uredo paraphysata sp. nov.

Uredosoris amphigenis, sparsis vel in greges parvos collectis, in maculis decoloratis dispositis, rotundatis, 0.1–0.3 mm. diam., mox nudis, pulverulentis, cinnamomeo-brunneis, epidermide rupta non conspicua; paraphysibus numerosis, clavatis vel clavato-capitatis, plus minusve incurvatis, 13–15 × 48–64 µ; tunica infra pallide, tenui, supra castaneo-brunnea vel pallidiore, 2–3 µ incrassata; uredosporis late ellipsoideis, 19–24 × 24–29 µ; tunica cinnamomeo-brunnea, 1–1.5 µ cr., valde echinulata; poris 2 aequatorialibus.

On *Oliganthes* (?) *hypochlora* Blake. Caracas a Colonia Tovar, Dist. Federal, March 17, 1939, *Whetzel* & *Müller 3000.*

An interesting species because of the characteristic paraphyses with their brownish, thickened tips. The host doubtless belongs to the genus *Oliganthes* and Dr. S. F. Blake thinks it probably *O. hypochlora*. The genus is closely related to *Vernonia*. In fact some of the leaves of this collection bear sori of *Puccinia rotundata* Diet. which has been known previously only on *Vernonia*. Our *Uredo* does not, however, match any of the *Vernonia* rusts known to us.

Uredo Pehriae sp. nov.

Uredosoris hypophyllis, sparsis vel laxe gregariis, parvis, ca. 0.1 mm., diam., cinnamomeo-brunneis, mox nudis, pulverulentis, epidermide rupta conspicua; uredosporis late ellipsoideis vel obovoideis, saepe leniter angularibus, $16–23 \times 24–29\ \mu$; tunica cinnamomeo-brunnea, $1–1.5\ \mu$ cr., moderate echinulata; poris 2–3, aequatorialibus vel super-aequatorialibus.

On *Pehria compacta* (Rusby) Sprague. Chirgua, Est. Carabobo, Dec. 15, 1939, *M. F. Barrus 3698*.

Several species of *Uredo* have been described on hosts of the family Lythraceae. The best known one is *Uredo Cupheae*. Our species differs from that in habit, having much smaller sori. Jackson has described *Uredo cupheicola* which differs in the larger spores. *Uredo Lafoenseae*, also described by Jackson, is similar but has larger sori and minor differences in the spore characters. It must be admitted that the four species have many characters in common.

In addition to the specimen cited we have found scant uredinia on two collections of *Aecidium Adenariae* on *Adenaria floribunda*, both from Medellin, Colombia. There is a possibility that *Uredo Pehriae* and *Aecidium Adenariae* may be stages in the life history of the same species.

UREDO RHOMBICA Speg. Anal. Soc. Ci. Argent. **17**: 124. 1884.

On *Astronium graveolens* Jacq. Road Maracay a Guigue, Est. Aragua, April 5, 1939, *Chardon, Whetzel & Müller 3322*.

Our specimen agrees with the description of *Uredo rhombica* in the characteristic rhomboid urediniospores, except that the spores are somewhat smaller. It has been reported previously from Paraguay and Brazil.

UROMYCES CISNEROANUS Speg., Anal. Soc. Ci. Argent. **10**: 134. 1880.

On *Sapium* sp. Rancho Grande, Road Maracay a Ocumare, Est. Aragua, March 29, 1939, *Chardon, Whetzel* & *Müller 3213.*

This specimen consists of the lower half of a leaf with a note that it had fallen from a tall tree. The teliospores agree so well with a Spegazzini specimen (No. *17,* Dec. Myc. Argentinae) that there can be no doubt about its identity. The host is a different species of *Sapium.* The rust has been previously reported from Argentina, Paraguay, and Brazil.

UROMYCES VIGNAE Barclay, Jour. Asiat. Soc. Bengal **60**: 211. 1891.

On *Vigna luteola* (Jacq.) Benth. Caracas, Dist. Federal, July 20, 1938, *A. S. Müller 2181,* July 28, 1938, *A. S. Müller 2182.*

Only urediniospores are present. They agree with the characterization of this species as set forth by Fromme (Phytopath. **14**: 67–79. 1924.), especially in the two pores which are evident and superequatorial. This species is similar to *Uromyces appendiculatus* but the latter has 2–3 obscure, equatorial pores. *Uromyces Vignae* is a cosmopolitan species. It has not been previously reported from Venezuela.

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LIFE HISTORY OF CERCOSPORA ON SWEETCLOVER [1]

Fred Reuel Jones [2]

INTRODUCTION

One of the most common and easily recognized of the leafspots of sweetclover is caused by a species of *Cercospora*. An equally common, but less frequently distinguished stem blackening of cultivated sweetclover is caused by the same fungus. On overwintered stems of sweetclover a species of *Mycosphaerella* was found in 1937 which gave cultures of *Cercospora* indistinguishable from those obtained from conidia of this fungus, and later the spermogonial stage of this fungus was found. The evidence which links the three forms of this fungus is here presented.

OCCURRENCE OF CERCOSPORA ON SWEETCLOVER

Well developed spots caused by *Cercospora* are found chiefly on older leaves of sweetclover. These spots are usually few, circular, ashy gray to tawny or have black centers when conidiophores are abundant. Infected leaves soon shrivel and drop. On stems the fungus produces discolorations differing greatly with the age and maturity of the stem. On stems of the first year's growth reddish brown lesions somewhat zonate or with diffuse edges often develop in autumn after frost. The fungus can often be isolated from stems which show only tiny discolored flecks. On growth of the second year the fungus usually becomes conspicuous when the plants are about to blossom. It is often found early on stems which are dying back after having been cut or grazed. On such stems it may fruit abundantly in wet weather. Thick stands forced to early maturity by insufficient moisture sometimes be-

[1] Contribution from the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Dept. of Agriculture, in cooperation with the Wisconsin Agricultural Experiment Station, Madison, Wis.

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come heavily infested so that the stems turn black, and after a dewy night these stems may have in early morning a discernable white sheen from the quantity of conidia produced. Pedicels become infected, maturing seed may fall prematurely, and the seed itself may be penetrated and carry the fungus (**5**). The fungus varies greatly in abundance from year to year. Carver (**1**) in 1901 reported *C. Davisii* as being destructive to foliage of sweet-clover (*M. alba*) in Mason County, Alabama. This fungus often occurs in association with *Mycosphaerella lethalis* Stone, the so-called black stem fungus, which causes a somewhat similar discoloration of stems. Stem blackening from *Cercospora* and other fungi is usually found much more severe in second year's growth that has been clipped or grazed than in stands which make their complete growth without defoliation.

THE CONIDIAL STAGE

Cercospora on sweetclover appears to be recorded in Europe under the name *C. Meliloti* Oud. (**2**, p. 23), the oldest name given to a species in this genus on *Melilotus*. *Cercospora* was first described on *Melilotus alba* in the United States under the name *C. Davisii* Ellis & Ev. (**3**). Horsfall (**4**) has concluded on the the basis of excellent evidence in the literature—no European collection being available—that the fungus is not that described by Oudemans. Furthermore, Horsfall (l. c.) concluded on the basis of evidence from herbarium material that only one morphological species in the genus *Cercospora* occurs on species of *Trifolium, Medicago* and *Melilotus,* and that the oldest name, *C. zebrina* Pass. should be used for it. This usage has been generally followed. Later Nagel (**7**) made inoculation with *Cercospora* from *Melilotus* on 16 species in the genera *Medicago, Trifolium* and on *Melilotus alba* and infected only *Melilotus alba*. Thus it appears that this evidence of the specificity of the *Cercospora* on *Melilotus* together with the following evidence of a distinct life history provide good reason for retaining the name *C. Davisii* for this fungus.

THE SPERMOGONIAL STAGE

In autumn small pycnidia with minute spores that appear to be spermatia often appear abundantly on blackened stems that have

borne the conidial stage earlier. None of these have been found upon leaves. At first they overflow with many spermatia, but in late fall they may be quite empty. The spermatia have not been germinated. This stage of the fungus has been cultured only by lifting the tiny structure out of the stem tissue with a needle under a binocular and transferring it to an agar substratum. When this has been done in late autumn after the stems have weathered a little these structures send out mycelium of *Cercospora* alone in a majority of the transplants.

Further evidence that these structures developed from the mycelium of *Cercospora* was obtained as follows. When it was found that they did not develop on stems inoculated in a warm greenhouse, and appeared in the field only after the arrival of cool weather, pieces of infected stems of greenhouse plants were incubated in a series of chambers held at temperatures from 8 to 32 degrees C. with 4 degree intervals. At temperatures from 8 to 16 degrees these spermogonia developed in from 3 to 4 days at 16 degrees and in about 10 days at 8 degrees. At 20 degrees and above only conidia of *Cercospora* were produced on the stems, while at 16 degrees and below only a few conidia were produced along with spermogonia. Stems from the field blackened by *Cercospora* were found to produce spermogonia when placed at the temperature range indicated above long before these structures appeared in the field. Thus their development appears to be conditioned by temperature. The fact that these spermogonia develop on inoculated plants which appear to be free from other fungi under the same conditions that favor their appearance in the field is taken as strong supporting evidence that they belong in the life cycle of the fungus. The spermogonia have not developed in pure culture even upon *Melilotus* stems, however.

The precise development of the spermatia has not been traced in cytological preparations. The development of the spermogonia has been observed on inoculated stems after they have dried for at least two months in the greenhouse and where little contamination from other fungi was found. From this, it appears that the spermatia develop in the manner described by Wolf for *Cercospora sordida* Sacc. (**10**) or by Jenkins for *Cercospora arachidicola* Hori (**6**). On the bleached stems incubated in a moist

chamber the stromata giving rise to the spermogonia are quite hyaline and the surrounding wall is poorly developed, and may occasionally grow out as conidiophores from which conidia are developed, especially if the temperature is raised after spermogonia are initiated. Thus it appears possible that conidia might develop from overwintered mycelium to perpetuate the fungus in the failure of the ascigerous stage, though this has not been observed in the field.

It appears more probable that such overwintering occurs with the *Cercospora* on alfalfa, where stems blackened by the fungus have been searched in vain for any evidence of a following spermogonial or ascigerous stage, either in the field, or when such stems have been incubated at temperatures at which the spermogonial stage appears upon sweetclover.

THE ASCIGEROUS STAGE

The perithecial stage of this fungus has been found to differ greatly in abundance from year to year since it was first found in the autumn of 1937. In 1938 none of it was discovered. When it occurs it is often so mixed with other ascomycetes which are abundant on sweetclover stems that good material for the herbarium cannot be separated, and it has often been identified by culture from groups of ascospores discharged from scattered perithecia upon agar. It seems probable that the development of the perithecial stage is conditioned by suitable rainfall when the spermogonia develop, as in the case of *Mycosphaerella arachidicola* W. A. Jenkins upon peanut (6 p. 322), and that this dependence upon climate may account for its fluctuations in abundance. Since the perithecia are inconspicuous in the tissue of the stem and can hardly be distinguished by outward appearance from those of other species often present on stems, their presence is best determined by placing moistened strips of bark over plates of clear agar and searching the agar for characteristics spores.

Mature perithecia are found at Madison, Wisconsin, about the first of June, and spores may be discharged more or less abundantly during the entire summer. No previous description has been found of this highly inconspicuous stage of the fungus.

CULTURAL CHARACTERS

The cultural characters of this fungus have been so well described by Nagel (**8**) and of similar species by Jenkins (**6**) that little new information can be added. The fungus grows on common culture media, and the chief problem encountered has been in inducing the formation of conidia. Nagel's experience (l.c.) that the best culture medium for conidial production should have only so much agar in it as was necessary to allow the inversion of plates without having the agar flow was corroborated. When such agar was used conidial production was obtained in transfers even from old dried cultures. Such cultures were macerated in a little water, which was poured over an agar plate, and after the debris had settled, the surplus water was poured off. In 3 or 4 days when a few conidia began to appear they were washed from this plate with a little sterile water and poured over a new agar plate where conidia usually became abundant. Old cultures of *Cercospora* from sweetclover, red clover and alfalfa responded to this treatment but one culture from *Medicago lupulina* did not. Inoculation was often conveniently made by touching leaves to the surface of a spore bearing plate.

INOCULATION EXPERIMENTS

Inoculation trials were made in the usual manner and thus need not be described in detail. Infection was always far more successful in the older leaves of plants and on the stems of second year growth of sweet clover after blossoming had begun. In fact, no visibly successful infection of first year stems was made in the greenhouse. From isolations in the field it is known that such stems are infected, though perhaps rarely or never with the fruiting of the fungus. Lesions developed far more abundantly and rapidly in plants placed in a moist chamber over night from time to time after the original inoculation than in those which remained in the greenhouse.

Inoculations have been made with cultures of *Cercospora* from sweetclover, alfalfa and red clover upon all three of the hosts, but infection has been obtained only upon the host from which the culture was derived. Thus pending a satisfactory account of the

life histories of the *Cercosporas* on alfalfa and red clover it appears more convenient to regard them as distinct species.

RESISTANCE TO STEM BLACKENING BY CERCOSPORA

Evidence of resistance to stem blackening by *Cercospora* has been sought by Dr. W. K. Smith and the writer in the former's breeding nursery containing hundreds of selections of both *Melilotus alba* and *M. officinalis.* Differences in stem blackening in early summer are often found to be correlated with the maturity of the strains compared, and appear to represent only the commonly observed correlation between maturity and infection mentioned previously. However, conspicuous instances of extreme blackening or failure to blacken have been found which persist, and do not appear to represent such correlations. Extreme and uniform resistance has been observed through two summers in selfed lines of *Melilotus alba* derived from three resistant plants selected by Dr. Smith in a planting from seed collected by Westover and Wellman in Turkey in 1936, and designated by the Foreign Plant Introduction number 120,048. The remarkable freedom from blackening in stems of these strains through two summers in which it has been observed may be taken as indicating that they are also resistant to the black stem fungus, *Mycosphaerella lethalis.*

TAXONOMY

A technical description of the fungus is presented herewith.

Mycosphaerella Davisii sp. nov.

Perithecia often few and scattered, inconspicuous on dead overwintered stems, developing beneath the epidermis through which the ostiole opens, spherical, dark in color, 70–100 μ in diameter. Asci cylindrical to club shaped, grouped at the base of the perithecia from which they appear to develop in succession for a long period in the summer, eight spored, without paraphyses 40–60 $\times$ 10 μ. Ascospores irregularly biseriate with median septa, hyaline, straight along one side or slightly curved, and bluntly pointed at the ends, 12–20 $\times$ 4–5 μ.

Spermogonia developing in late summer and autumn on mature and dying stems only, thickly scattered, especially at the margins of lesions, black, subepidermal, erumpent, often flattened and ap-

proaching an acervulus in form, with ostiole variable in size, 80–120 μ in diameter. Spermatia rod shaped, about $1\frac{1}{2}$–3 × 1 μ.

The original description of the conidial stage, *Cercospora Davisii* Ellis & Ev. has been emended by Solheim (**9**) as follows.

"Spots amphigenous, subcircular, more or less vein limited, at times confluent, 1–5 mm., greenish yellow to dark brown; border indefinite or in part definite, slightly raised, yellowish-brown, 1.5–4.5 μ. Conidiophores amphigenous, loosely or somewhat densely tufted, emerging through the stomata or rupturing the epidermis, simple, straight to subflexuous, with or without a bulbous base, arising from a stroma of loosely to fairly compactly woven hyphae; pale dresden brown, 20–85 × 3–6 μ; continuous or 1–2 septate above bases; conidial scars distinct, shouldered, mostly aggregated towards the tips. Conidia at first cylindrical, then acicular, subhyaline to light greenish yellow, 20–140 × 2.2–4.5 × 1.2–2.5 μ, at first continuous, becoming closely 1–13 septate."

On leaves and stems of *Melilotus alba* and *M. officinalis*. Type collections of the ascigerous and spermogonial stages have been deposited with the Mycological Collections of the Bureau of Plant Industry of the U. S. Dept. of Agriculture, and in the Herbarium of the University of Wisconsin.

Perithecis in caulibus mortuis saepe sparsis, immersis, erumpentibus, globosis, 70–100 μ, nigris, ostiolatis; ascis cylindraceis vel clavatis, brevissime stipitatis, aparaphysatis, fasciculatis, octosporis, 40–60 × 10 μ; sporidiis subbiseriatis, bicellularibus, hyalinis, curvulis, 12–20 × 4–5 μ; spermogoniis autumno in caulibus maturissimis efformatis, plerumque ad macularum margines, nigris, saepe ostiolis latis et irregularibus, 80–100 μ; spermatiis bacillaribus, hyalinis, 1.5–3 × 1 μ. Statu conidico Cercospora davisii Ell. et Ev.: maculis in foliis amphigenis, fuligineo-brunneis, orbicularibus, in caulibus emortuis elongatis, indefinitis, confluentibus, atro-brunneis vel nigris; hyphis amphigenis, rufescentibus, rectis, fasciculatis vel singularibus, e stromate delimitato oriundis, geniculatis, continuis, deinceps septatis, 20–80 × 3–5 μ; conidiis hyalinis usque viridiflavidulis, cylindrico-acicularibus, multiseptatis, 20–140 × 3–6 μ.

Hab. in foliis caulibusque Meliloti spp. (U. S.).

SUMMARY

The life history of *Cercospora Davisii* Ellis & Ev. on *Melilotus* spp. appears to have been completed by the finding of the spermogonial and the ascigerous stage. The development of the spermogonial stage appears to be dependent upon a temperature below 20

degrees C. The ascigerous stage found on overwintered stems is described as *Mycosphaerella Davisii.* Evidence of resistance to stem blackening by this fungus is recorded.

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ON THE DATES OF PUBLICATION OF SCHWEINITZ'S SYNOPSES

Donald P. Rogers

The first paper on American fungi, the "Synopsis fungorum Carolinae Superioris secundum observationes Ludovici Davidis de Schweinitz," was published in the first (and only) volume of the *Schriften der naturforschenden Gesellschaft zu Leipzig*. That volume bears on its title-page the date 1822, and that year has in consequence usually been taken as the year of publication of Schweinitz's work. By some authors, however (e.g., Pennell, Bartonia **16**: 4. 1934 (but see also his footnote 5); Kellerman, Jour. Myc. **2**: 31–34. 1886; Johnson, A memoir of the late Lewis David von Schweinitz, P.D. Phila. 1835), the year has been given as 1818—perhaps in part because the manuscript was "laid before the Gesellschaft" on December 7, 1818 (Naturf. Ges. Leipzig Schr. **1**: 212. 1822). Furthermore, the possibility has existed that separate copies of Schweinitz's work were issued in advance of the publication of the complete volume, and might therefore have a separate date. If Schweinitz's paper was published before 1821, it of course falls under the deadly obloquy of being pre-Friesian. Furthermore, in 1822 there were published several important mycological works, whose relative dates seem not to have been established. It is therefore a matter of some importance to determine as accurately as possible the date of the "Synopsis," in order that the nomenclatorial status of that important paper may be known.

The article immediately preceding Schweinitz's in the complete volume of the *Schriften* was read March 14, 1820, as a memorial to a man who died February 29, 1820 (p. 12); a footnote (p. 16) refers to an article published March 25, 1820. Now the first page of the introduction to the Schweinitz article (p. 20) occupies the verso of the last page (p. 19) of that obituary notice, and must have been published with it; the two articles are as closely tied together as are Fitzpatrick's and Orton's in the current volume

of *Mycologia* (cf. Mycologia **36**: 17, 18). From this alone, then, the earliest possible date for the publication of the "Synopsis" in the *Schriften* is one later than March 25, 1820.

The last page (p. 131) of the Schweinitz article occupies the recto of the leaf on which it is printed; on the verso of the same leaf (p. 132) begins a paper by Wellner; these two must also have been published together. Next, p. 139 of Wellner's paper is on the recto of the first page of a paper by Clarus. This paper by Clarus is marked (p. 140) as having been read April 10, 1821, a still later date to which the publication of the "Syn. Fung. Car." probably was not antecedent. The last page (p. 147) of Clarus's article occupies the recto of the first page of one by Cerutti; Cerutti's paper ends on p. 157 (recto), and the next paper, by Radius, begins on the verso of the same leaf (p. 158); Radius's article ends on p. 161 (recto), and one by Schmidel begins on p. 162 (verso). The latter deals with meteorological data for the entire twelve months of 1821, and consequently neither it nor the papers joined to it could have been published as parts of the *Schriften* before 1822. Schmidel's article ends on p. 174 (verso); since its pages 169–70 are conjugate (that is, continuous through the binding, and therefore printed on the same sheet, and simultaneously) with pp. 175–76 of the following article, by Müller & Kunze, it does not even so interrupt the series. This paper by Müller & Kunze is dated (p. 176) April 6, 1822—the latest date incontestably joined to Schweinitz's paper. Nevertheless, the concatentation of articles remains unbroken through the index, which ends on p. 232. That is, quite by chance no article is of such length as to fill up the gathering of eight pages which was printed at one time on one sheet of paper. Since there are no blank pages, it follows that at least through p. 232 the *Schriften* was printed and in all probability published as a unit, and that the date April 6, 1822, is tied to the Schweinitz paper by much more than the binding of the volume.

After the index there follows a set of day-by-day weather-tables for 1821, without pagination, and dated on the last page July 18, 1822. These tables, present in at least two copies of the *Schriften* (Farlow Library, and my own) are printed on the same paper and in the same styles of type as the rest of the volume, and appear

to be a part of it. Unfortunately, the chance that served to join together all the rest operated to separate this last article: the weather-tables begin on the first page of the gathering, and therefore may just possibly have been subsequently printed and—what is more important—subsequently dated. Next comes a table of contents, in which the unpaged weather-tables are set down as commencing on p. 233, and after that, the seven plates. Because the table of contents lists the weather-tables, it is quite probable that they, with their date of July 18, 1822, formed a part of the *Schriften* as issued; but that cannot be proved from the evidence at hand.

Since the volume of the *Schriften* is dated 1822, Schweinitz's "Synopsis" probably was not issued before that year unless it appeared as an advance separate. Now there does exist a separate issue of the "Synopsis." As is generally known, Schweinitz's paper was published by Schwaegrichen, the editor of the *Schriften,* from Schweinitz's manuscript but without his knowledge. For the *Schriften* Schwaegrichen wrote a long introduction (pp. 20–27) and commissioned an illustrator to prepare the two plates.[1] The separate issue lacks that introduction; in the place of its last page the separate carries a title-page different from the heading appearing (p. 20) in the *Schriften.* It differs also in pagination, its pages running from 2–105 instead of 28–131 (whence the pagination given in the separate can be corrected by adding 26 to the numbers printed at the head of its pages), and in the signatures, which run from B (on p. 7) to O (on p. 103), instead of from E to R. Irregularities in the type (e. g., broken *s* and *t* in *ostiolis,*

[1] Arthur (Amer. Naturalist **17**: 77. 1883) and Shear & Stevens (Mycologia **9**: 195. 1917) have supposed that Schweinitz's "great microscope" was used in the preparation of the descriptions for the "Syn. Fung. Car." That would seem not to be the fact. In his letter to Torrey of June 24, 1820 (cf. Shear & Stevens, Torrey Club Mem. **16**: 125. 1921), Schweinitz wrote "Since my return, having provided myself with instruments and books . . ."; and the implication is that he had provided himself with "instruments" only after his return from his European travels of 1817–18, during which he left the manuscript of the "Synopsis" with Schwaegrichen. In the introduction to the "Synopsis" Schwaegrichen wrote that he had added to Schweinitz's notes "description of the more minute parts, drawn up under a stronger microscope, of which the author himself was destitute, and illustrations . . ." (Naturf. Ges. Leipzig Schr. **1**: 27. 1822).

p. 9, or p. 35, l. 23) are, however, the same in the separate copies (Farlow Library, Brown University library) as in the complete volume; and therefore, whatever alterations were made in pagination, the text was set in type but once. The question is then whether the "Synopsis" (a) was first set up and printed as a part of the *Schriften,* and afterwards reprinted, with page-numbers and signatures changed, or (b) was printed separately in advance, and afterwards altered so as to be incorporated in the *Schriften.* Now in the separate copy the article commences on the left-hand page, as in the complete volume; if it had first been printed in the separate form it would almost certainly have begun on the right-hand page. What is more, in the separate edition the first signature (B) is printed at the foot of p. 7, after only six pages (title-page and five pages of text), rather than after the full eight pages which normally would make up a gathering; it thus occupies the same position as signature E of the *Schriften.* The only explanation of these anomalies seems to be that the separate was printed from the same types as the complete volume without rearrangement of the forms. From this it follows that the forms were first assembled for the printing of the complete edition, and the separate is not an advance publication, but an extract. Furthermore, it follows from the evidence of the concatenation of the papers, and would be indicated by the signatures alone, that the *Schriften* was set up as a unit, and not as an assemblage of parts or numbers; it is not a periodical at all. It is equally apparent that it cannot have appeared as a completed volume before April 6, 1822, and if, as seems to be the case, the weather-tables and table of contents form a part, it cannot have appeared before July 18, 1822.

As must be the case with almost any volume ever printed, there is a possibility that the *Schriften* was issued, as well as printed, a gathering (or a few) at a time—even though each portion, of whatever size, must necessarily have been incomplete. If such a possibility be allowed, the "Synopsis" cannot be shown certainly to have been issued much later than March 25, 1820. But since more than half the volume must have been completed before the completion of the "Synopsis," and since the whole does not represent a very extensive job of printing, that possibility seems remote, and no more worth considering for this than for any coeval work.

So much for internal evidence. The earliest notice of either the *Schriften* or the "Syn. Fung. Car." seems to be that in a semi-annual *Verzeichnis neuer Bücher*. The volume of this publication for the first half of 1821 faithfully records the appearance of Fries's *Systema,* vol. I; that for the second half of the year lists the German edition of Persoon's *Traité sur les Champignons* (although the title-page of that edition is dated 1822); the volume for the first half of 1822 reports the publication of Persoon's *Mycologia europaea,* pt. I; but no Schweinitz. Finally on p. 96 of the *Verzeichnis neuer Bücher, die vom Juli bis Dezember 1822 wirklich erschienen sind* (J. Hinrichschen Buchhandlung . . . Leipzig. 1823) is listed the *Schriften.* Since the society which published Schweinitz's paper met, and published its Journal, in the city where the *Verzeichnic* was published, there appears no reason to suppose a great delay in reporting its appearance. The *Schriften* was noticed, and Schweinitz's paper made the subject of an extensive critical review by Nees von Esenbeck, in Flora **6** (**2**): Beil. 65–86. 1823. It seems safe then to set the date of publication in the second half of 1822—later than the *Systema,* vol. I, later than Gray's *Natural Arrangement,* later than sect. I of the *Mycologia europaea,* probably later than July 18. It is earlier than vol. II (1) of Fries's *Systema,* in which the *Synopsis* is frequently cited (e. g., *S. M.* **2** (**1**): 12, under *Morchella patula*).

According to a letter from Schweinitz to Torrey published by Shear & Stevens (Torrey Club Mem. **16**: 165. 1921), Schweinitz received copies of the "Synopsis" in time to send one to Torrey on November 24, 1822. Deduction of the estimated time required to bring the paper from Leipzig to Bethlehem would provide a fair approximation of the latest possible date of publication.

According to the decision of the Amsterdam Congress (Zesde Int. Bot. Congr. Proc. **1**: 343–344), the date of publication of groups published both in advance separates and in a complete volume is the date *on* the separates, or of the journal. Since the "Syn. Fung. Car." as separately published carries no date, under that rule the groups published in it were published on the date of the whole volume, regardless of any possibility that separates were issued somewhat earlier.

The date of Schweinitz's "Synopsis Fungorum in America Boreali media degentium" is less critical than that of the earlier "Synopsis," has less often been incorrectly stated, and can be established with less difficulty. The "Syn. Fung. Am. Bor." was published in volume 4 of the new series of the Transactions of the American Philosophical Society. That volume bears on its title-page the year 1834; the article is marked (p. 141) as having been communicated to the society April 15, 1831; and both 1831 and 1834 have occasionally been given as the date for the Schweinitz paper. The series of letters published by Shear & Stevens, however, provides adequate information for determining the true date. On May 24, 1832, Schweinitz wrote to Torrey "that my Synopsis of American Fungi—is very nearly printed" (Torrey Club Mem. **16**: 275. 1921). On July 29, 1832, the librarian of the American Philosophical Society wrote to Schweinitz, "I have the pleasure of sending you six copies of your work making part of [our] 4th vol. N. S." (Mycologia **9**: 198. 1917). The "Syn. Fung. Am. Bor." was then issued some time between May 24th and July 29th, 1832. Now the *Transactions* were "published in numbers, at short intervals" (Amer. Phil. Soc. Tr. n. s. **4**: [iii]. 1834), and the "Synopsis," published as "Article VIII" (Amer. Phil. Soc. Tr. n. s. **4**: xii. 1834), apparently constituted such a number. The status of Schweinitz's paper when first issued was therefore not that of a "separate" (ascribed to it by Shear & Stevens in Mycologia **9**: 198. 1917) but that of a number of a serial appearing at irregular intervals; and its date of publication is not 1831, nor 1834, that of the volume of which it forms a part, but about the middle of the year 1832.

I am indebted to Miss Marjorie W. Stone of the Gray Herbarium and to the Widener Library of Harvard University for assistance in finding early notices of the *Schriften,* and to the Farlow Library of Harvard and the Biological Science Library of Brown University for access to their copies of Schweinitz's work.

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A NEW PSEUDONECTRIA ON PACHYSANDRA

B. O. Dodge

(WITH 13 FIGURES)

A brief account of canker disease of pachysandra was recently published by the writer (**1944**). It had been observed that the species of *Volutella* present on cankered or blighted stems, and proved by tests to be the cause of the disease, was not the species described by Hutchinson (**1929**). Dr. Freeman Weiss in a letter had pointed out that Clinton (**1934**), White (**1935**), and Pirone (**1942**), had reported on the same disease independently. There is, then, complete agreement that the conidia of the "long spored" *Volutella* are about 14–20 μ in length, while those of *V. Pachysandrae* Hutchinson were only 2.3–6 μ in length. Hutchinson (**1929**) says in his description of the sporodochium: "minutis 5–6 mm. in diameter." These measurements, though repeated three times, might have been a misprint. The stems themselves are often not over 6 mm. in diameter. A 6 mm. sporodochium could not very well be called "minute."

Pirone (**1942**) gives us an excellent description of the disease. He also reports on his inoculation experiments, proving for the first time that this long-spored *Volutella* is a wound parasite capable of appearing in epidemic form.

Just what fungus Hutchinson had before him the writer cannot make out from an examination of what is labeled as co-type material loaned by Dr. Weiss. There can be no question as to the real cause of the canker-blight disease of pachysandra. It is the long-spored *Volutella* which all, except Hutchinson, have found on this host. The sporodochia (see Dodge **1944**, p. 162) vary in size up to about 400 μ in diameter. The conidia are hyaline, one-celled, 14–24 × 2–4 μ, pointed at the ends. In culture on potato dextrose agar the conidia are in mass salmon-pink and vary more in size and shape. The tapering hairs which are faintly colored, and 100–200 μ long and 5–10 μ broad, at the base, may appear as

soon as the sporodochium breaks through the epidermis. They may also grow out later either from around the margin or up through the conidiophores. Ordinarily the sporodochia are dull amber or ochraceous, or, according to White (**1935**), russet colored. From about the first week in June one may expect to find sporodochia which are rather reddish in color, indicating that they are becoming stromata on which perithecia will develop. During July, especially in dry weather, it seems, fewer new sporodochia bearing masses of condia are present. Stromata with from one to several incipient perithecia are very abundant. Even in the youngest perithecial body there appears at the center a little spot suggesting the beginning of an ostiolar structure (FIG. 5). In a few crushed mounts two or three thread-like flexuous hyphae were found growing out at this point (FIGS. 5, 6). It may be that they are the receptive structures. Whether the clusters of branched sporophores, such as are shown in figure 7, represent spermogonia or not is also a question. Apparently during the summer incipient perithecia develop on stromatic masses which are reddish in color even as they burst through the bark. This means that in nature the stroma may develop without first functioning as a sporodochium. If stems bearing such stromata are moistened well and held in a damp chamber the stromata sporulate so that masses of conidia are formed.

Young perithecia are roughly granular. This is due to short, coarse, light-yellowish to reddish setae (FIG. 10) which project a short distance from the wall of the perithecium. The dome of the mature perithecium is usually rather smooth. It may be that some of the stubby hairs slough off as the fruit body expands and matures. Figures 8 and 9 show the surface condition in section diagram. When mature perithecia, which are about 230–280 $\times$ 200–250 μ, are picked off, some of the stroma, 100–150 μ in thickness, is often attached to the base (FIG. 9). Even mature perithecia may collapse when dry, but after the full complement of asci, some two hundred or more, develop, the perithecial wall is more apt to remain firm and retain its form. The color varies slightly from orange-red to carmine-red.

Mature asci are about 60–80 $\times$ 7–10 μ. Figure 11 shows the distribution of the ascospores in three asci. The spores are about

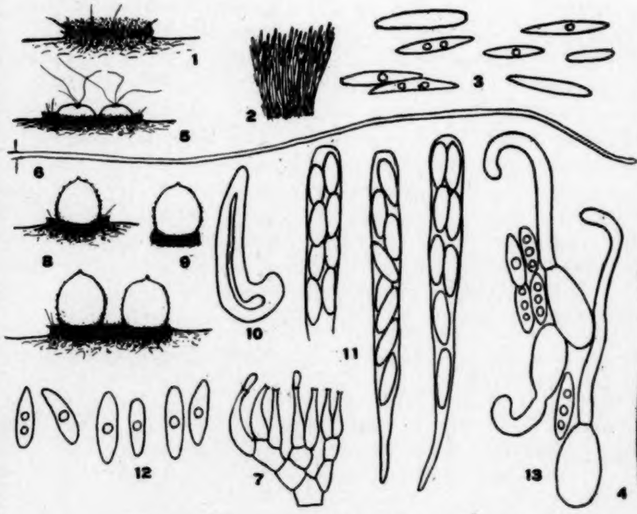
10–15 × 3–4.5 μ, and are usually marked by one or more oil droplets (FIG. 12). The droplets were not drawn in in the spores shown in figure 11. The method of spore dispersal has not been observed. Occasionally one finds perithecia from which the dome part has broken away completely, leaving only a shell for a basal portion. An ostiolar opening is certainly not very evident, even in crushed mounts of mature perithecia.

Ascospores germinate very readily even while they are still inclosed in the ascus. That the spores swell greatly as they germinate is clear from figure 13, where the perfectly mature and normal spores, which have not yet grown, are shown with the same magnification to be much smaller. Here three of the eight spores had already germinated within 18 hours. The other five would, no doubt, have germinated later.

Cultures from single ascospores are like those from single conidia. As a rule, mixed cultures derived from several spores from the same ascus are brighter colored and often a little more vigorous than are cultures from single ascospores or conidia. The cultural characters, as well as the fact that perithecia so commonly develop directly from old sporodochia functioning as stromata, are further evidence of the connection between the *Volutella* and the perithecial stage. The first conidia formed on mycelia from the two kinds of spores, condia and ascospores, may be rather large and have rounded ends (FIG 3 above), but most conidia in old cultures are more broadly spindle-shaped and have sharply pointed ends. Conidia are usually longer than are the ascospores. Living leaves and stems of pachysandra inoculated with conidia from ascospore cultures developed typical *Volutella* sporodochia and conidia.

Since the ascocarpic stage described above clearly belongs in the family Nectriaceae, it remained to determine to which genus of this family the species should be referred. After consultation with Dr. F. J. Seaver, who monographed the Hypocreales some years ago, it was concluded that the species belongs in the genus *Pseudonectria* Seaver (**1909**). He designated *Nectria Rousseliana* Mont. as the type of the genus. Further indications that these two species are congeneric are: First, both have a *Volutella* for their conidial stage, and, second, both occur on members of the

same host family Buxaceae. Furthermore, a fact not ordinarily observed is that the perithecia of *Pseudonectria Rousseliana* (Mont.) Seaver (**1909**) [1] sometimes develop from the *Volutella* stroma. Weese (**1932**), writing from Höhnel's notes, says of *Volutella Buxi* (DC.) Berk.: "Häufig bilden sich am Polster auch die Perithezien der *Pseudonectria Rousseliana* (Mont.)." The writer has also observed that while most of the perithecia he has found on boxwood leaves arise directly from a superficial mycelium, occasionally they may arise from a definite stromatic



FIGS. 1–13. *Pseudonectria pachysandricola.*

tissue resembling an old sporodochium, well decorated with characteristic hairs. This character, the origin of perithecia from stromata, as noted above, is very prominent in the species on pachysandra. It is, therefore, proposed to describe it as a new species of *Pseudonectria.* Those who follow Seaver's (**1909**) scheme of placing genera with stromata and those without stro-

[1] Seaver (**1909**) really made this combination by inference, and we are giving him credit for the combination although some might differ with us on this point.

mata in different tribes, will simply shift the genus *Psuedonectria* from the tribe Nectrieae to the tribe Creonectrieae.

Pseudonectria pachysandricola sp. nov.

Peritheciis sanguineis subovoideis vel subglobosis, 240–280 × 200–225 μ, confertis stromate erumpentibus, ostiolo minuto papillato; ascis subclavatis, 60–80 × 8–10 μ, octosporis; ascosporis uniseriatis vel biseriatis, non septatis, hyalinis anguste ellipsoideis, 10–15 × 3–5 μ.

Status conidicus **Volutella pachysandricola.** Sporodochiis amber-ochraceis, 100–400 μ diametro; setis 100–200 × 5–8 μ; conidiis hyalinis fusiformibus, 14–20 × 2–4 μ, guttulatis.

Perithecia 240–280 × 200–225 μ, subovoid to subglobose, usually arising singly or several in a group from an old sporodochium of the *Volutella* stage, which becomes a stromatic base, orange-red to carmine-red, at first rough, due to short, thick-walled setae, with a short papillate ostiole; asci clavate, 60–80 × 8–10 μ, 8-spored; ascospores hyaline, at first 1-seriate, becoming irregularly 2-seriate, narrowly ellipsoid, 1-celled, guttulate, 10–15 × 3–5 μ.

Conidial stage. Sporodochia ochraceous to amber or light russet, 100–400 μ in diameter, with colorless or only faintly colored 1-celled setae, 150–200 μ long, 5–8 μ thick at the base; conidiophores long, narrow, branched, pale-tan in mass or somewhat orange-reddish as the sporodochium becomes a stroma; conidia hyaline, 1-celled, spindle-shaped, 14–20 × 2–4 μ, guttulate.

On *Pachysandra terminalis*, spring and summer.

Type locality: New York.

Distribution: Eastern United States.

Illustrations: Jour. N. Y. Bot. Gard. **45**: 162. 1944.

SUMMARY

The canker-blight disease of pachysandra is caused by a new species of ascomycete, *Pseudonectria pachysandricola*, which is a wound parasite. The perithecia usually arise from stomata which represent the basal remains of sporodochia of the *Volutella* stage. The perithecial stage follows closely the conidial stage which is most in evidence during May and June, at least during periods where moisture is plentiful.

The connection between the two stages has been established culturally and by inoculation tests.

THE NEW YORK BOTANICAL GARDEN

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EXPLANATION OF FIGURES

Figs. 1, 2, 5, 8 and 9 sketched without regard to exact proportions. Other figures drawn with the aid of camera lucida and oil immersion lens.

Figs. 1–13. *Pseudonectria pachysandricola.* 1, section of a sporodochium of the *Volutella* stage; 2, cluster of conidiophores with conidia from a crushed mount; 3, conidia of various sizes and shapes; 4, a rather short, thick hair from a sporodochium; 5, two incipient perithecia arising from a sporodochial stroma, the flexuous hyphae may represent receptive organs; 6, one of these hyphae highly magnified; 7, branched cells resembling spermogonia, two of which are just forming microconidia? (from a crushed mount of a stroma with incipient perithecia); 8, 9, sketches to show shape and rough surface of walls of perithecia, the granules representing stubby hairs such as shown in figure 10; 11, three asci with spores variously distributed, oil droplets not indicated; 12, individual ascospores; 13, three of the eight spores from an ascus had germinated after swelling considerably, the other five spores with oil droplets are drawn to the same scale; the ascus wall had disappeared.

A NEW SPECIES OF ALTERNARIA ON FRUIT OF PHOENIX DACTYLIFERA [1]

DONALD E. BLISS

(WITH 3 FIGURES)

An interesting new species of *Alternaria* has been found among the fungi associated with the spoilage of date fruits in the Coachella Valley, California. This fungus is described as follows:

Alternaria stemphylioides sp. nov.

Coloniae in agaro Czapekii effusae, atro-olivaceae usque atrea; hyphis hyalinis, 3–6 μ in diam., septatis, ramosis; conidiophoris simplicibus vel ramosis, septatis, tenuibus, ad apices non inflatis; 3–8 μ in diam., usque 200 μ longis, tenuiter tunicatis, cellulis apicalibus atro-brunnescentibus, geniculatis, cicatricosis et latioribus quam cellulis hyalinis basilaribus; conidiis acrogenis, solitariis vel 2–3-catenulatis, brunneo-olivaceis, vetustis obscurescentibus, crasse tunicatis, verrucosis, forma variis, ovalibus, ovatis, rotundis, subangularibus vel obclavatis, ad septa constrictulis, muriformibus, septis transversalibus 0–9 (plerumque 1–4), longitudinalibus 0–3, magnitudine variis, rostro incluso 14–77 μ (plerumque 16–28 μ) longis, 10–17 μ latis, mediis 26.1 × 12.7 μ, rostratis vel erostratis; conidiis secundariis acrogenis e rostris conidiorum primariorum conidiophora secundaria formantibus productis. Hab. in fructibus *Phoenicis dactyliferae* L., Indio, California.

Colonies on Czapek's agar, effused, dark olive to black; hyphae hyaline, 3–6 μ in diameter, septate, branched (FIG. 1, *D*). Conidiophores simple or branched, septate, slender, not swollen at apex, 3–8 μ in diameter, up to 200 μ long, thin-walled, apical cells becoming dark brown, geniculate, scarred, and broader than the hyaline basal cells (FIG. 1, *A, C, G, H*). Conidia acrogenous, solitary or 2–3-catenulate, brownish olive, darkening with age, opaque, thick-walled, verrucose, irregularly shaped, oval, ovate, rotund, subangular, or obclavate, slightly constricted at the septa, muriform, with 0–9 (mostly 1–4) transverse and 0–3 longitudinal septa; size variable: length (including beak) 14–77 μ (mostly 16–28 μ), breadth 10–17 μ, and mean, 26.1 × 12.7 μ; nonbeaked or beaked, (FIG. 1, *B, G, H, I*). Secondary conidia produced acrogenously on the beaks of primary conidia, these beaks becoming secondary conidiosphores (FIG. 1, *B, r; G, H, I*).

HABITAT: Fruit of *Phoenix dactylifera* L., Indio, California.

[1] Paper No. 510, University of California Citrus Experiment Station, Riverside, California.

TYPES: Type specimen on Czapek's agar, deposited with the Mycological Collections of the Bureau of Plant Industry, Beltsville, Maryland. Cotypes sent to the Imperial Mycological Institute, Kew, Surrey, England; to the New York Botanical Garden, Bronx Park, New York City; and to the herbaria of the University of California, Berkeley, California, and of the University of California Citrus Experiment Station, Riverside, California.

Although chains of 2 and sometimes 3 conidia may occur, most of the conidia in *Alternaria stemphylioides* are solitary. There is a strong tendency toward unlimited apical elongation of the conidiophore. Spores are borne acrogenously, but may be moved rather quickly into lateral positions on the conidiophore by the elongation of the apical cell slightly to one side of the point of attachment. The elongating apex, either with or without cell division, forms a second conidium acrogenously, and then may repeat the process more or less indefinitely until as many as 15 conidia have been formed. These conidia may remain attached to the conidiophore or may be detached, leaving scars at the points of attachment.

Old conidiophores (FIG. 1, *C*) are geniculate, owing to the bending and distortion of the growing apex during the process of spore formation. The apical cells are usually broader than those at the base and they may be slightly swollen. There appears to be no thickening of the side walls, however, and no hyphal growth through the apical spore scar to form a new conidium, as illustrated and described by Wiltshire (8) for the true *Stemphylium*.

When grown on Czapek's agar (see "Cultural Characters"), some of the primary conidia become beaked (FIG. 2) and produce secondary conidia from the apex (FIG. 1, *G*), as is common in *Alternaria*. But at this point the tendency toward catenulation of spores usually stops. The beaked spores then continue to elongate at the apex, and secondary spores, although borne acrogenously, are pushed into lateral positions. Thus the beaks of these beaked primary conidia become secondary conidiophores with transverse septa, geniculations, and spore scars (FIG. 1, *B, r; I*). Chains of 3 spores are comparatively rare. In one instance 7 per cent of the spore chains contained 3 spores; the others contained only 2 spores each.

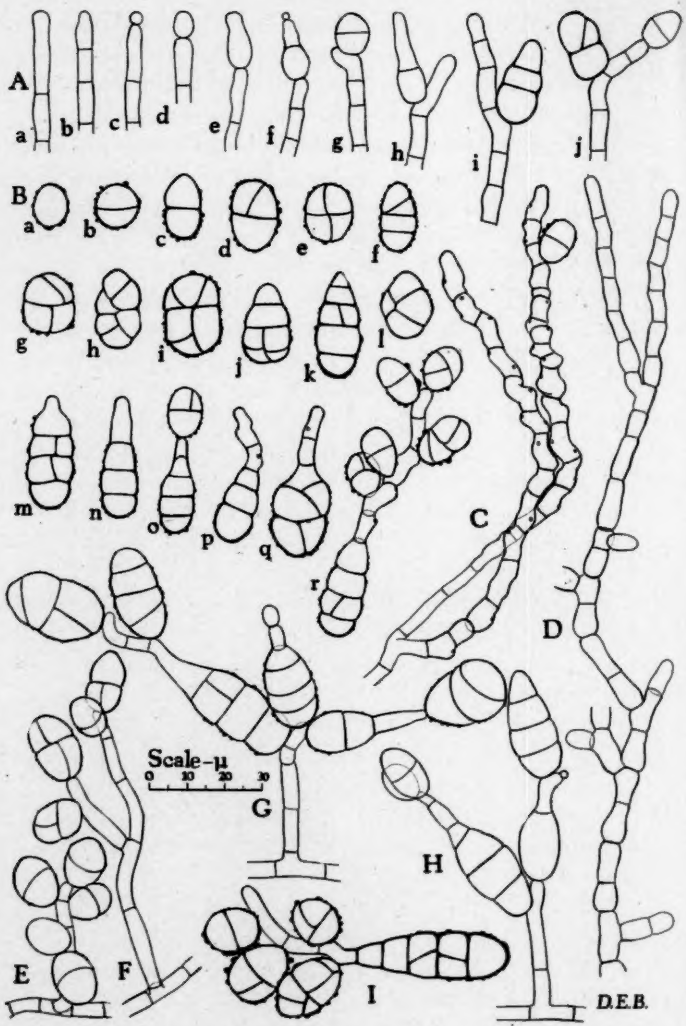

FIG. 1. *Alternaria stemphylioides.* *A, a–j,* young, rapidly growing conidiophores showing different stages in the development of conidia; *B,* conidia: *a–l,* nonbeaked; *m–r,* beaked—*r,* a primary conidium with elongated beak bearing five secondary conidia; *C,* an old, branched conidiophore with numerous cross walls, geniculations, and spore scars; *D,* mycelium; *E* and *F,*

Conidia of *Alternaria stemphylioides* are first seen as small, hyaline, spherical cells (FIG. 1, *A, c, f;* H). Swelling and elongation of the young spore is accompanied by the formation of the major transverse septum; later, other transverse, oblique, or longitudinal septa are formed (FIG. 1, *A, B*). The older spores on the conidiophore are usually larger than the younger ones. This is especially true where the oldest spores are beaked. Young spores are mostly regular in shape and have a smooth surface. Older spores sometimes become irregular in shape because of secondary cell division and growth, and are usually warty. The larger warts are blunt, irregular in shape, and about 1 μ in diameter. The spores, except for their subhyaline beaks, become very dark with age, and the septa can only be seen with difficulty. Constrictions at the septa are most pronounced in spores of irregular shape.

CULTURAL CHARACTERS

Alternaria stemphylioides is one of the fungi less commonly associated with spoilage of Deglet Noor dates in California. I have isolated it only twice: the first isolate (B-402) was obtained October 11, 1935, from a mature date having a soft, watery side-spot lesion with darkened center; the second isolate (B-718) was taken January 29, 1943, from another ripe fruit with a reddish-brown side spot. In both instances the symptoms of disease were similar to those usually associated with the side spot caused by *A. Citri* Ellis and Pierce em. Bliss and Fawcett (**1**).

Isolate B-402 had been cultured on corn-meal agar for a period of seven years before it was studied intensively. Because of the dark, oval-shaped, nonbeaked spores which it developed on this medium (FIG. 1, *E, F*), it had been tentatively referred to the genus *Stemphylium*. When cultured on Czapek's agar, however, this isolate produced chains of 2 or 3 spores, and numerous spores with beaks. The spores varied greatly in size and shape. The change was so marked that I suspected contamination by some form of *Alternaria*. But after culturing single spores of different

conidiophores and conidia as commonly produced on cornmeal agar (all other drawings are from the fungus as grown on Czapek's agar); *G* and *H*, young conidiophores with beaked primary and nonbeaked secondary conidia; *I*, primary conidium with elongating beak from which four secondary conidia have formed. ($\times$ 570.)

kinds from the colony, I discovered that all the spores belonged to the same fungus, and that these changes in spore form could be reproduced at will by varying the cultural environment.

Two strains (*A* and *B*) of isolate B-402 were retained for further studies. Strain *A* had originated from a beaked spore; strain *B*, from a spore without a beak. The development of these strains was observed in petri-dish cultures using five kinds of agar media (table 1). After 8 days at 26° C., the colonies on glucose

TABLE 1

DEVELOPMENT OF STRAINS OF ALTERNARIA STEMPHYLIOIDES ON DIFFERENT CULTURE MEDIA *

Medium	Mean radius of colony (mm.)	Spore size †				Beak formation	
		Length (μ)		Width (μ)			
		Range	Mean	Range	Mean	Number of spores observed	Percentage of beaked spores
Strain *A*							
Corn-meal agar	13	14–27	18.9	10–18	13.1	166	2.4
Glucose potato agar	22	13–33	19.6	9–17	13.2	170	7.1
Czapek's agar ‡	21	11–26	18.0	8–15	12.0	184	8.2
Vegetable agar §	22	12–39	21.3	8–15	11.4	223	12.6
Water agar	31	12–31	18.5	8–17	13.4	197	5.1
Strain *B*							
Corn-meal agar	13	14–23	18.1	10–16	13.2	388	0.0
Glucose potato agar	17	13–29	18.9	8–17	12.2	307	10.1
Czapek's agar ‡	15	12–34	20.4	8–15	11.4	282	13.5
Vegetable agar §	19	12–45	21.4	9–19	12.3	565	9.7
Water agar	32	12–31	20.0	9–22	14.4	400	4.2

* Cultures incubated 8 days at 26° C.
† Based on measurements of 25 spores from each colony.
‡ Containing 3 per cent sucrose.
§ See Mrak *et al.* (3).

potato agar, Czapek's agar, and vegetable agar (3) were dense and greenish black, while the colonies on the corn-meal and water agars were sparse and lighter colored. The mycelial growth rate was most rapid on water agar and more than twice that on corn-meal agar. The percentages of beaked conidia formed on the various media showed marked differences and were as follows: on corn-meal agar, 0.0 to 2.4; on glucose potato agar, 7.1 to 10.1;

on Czapek's agar, 8.2 to 13.5; on vegetable agar, 9.7 to 12.6; and on water agar, 4.2 to 5.1. Strains *A* and *B* gave reasonably similar responses in this experiment.

Further studies were then made on strain *B* with 2 per cent Czapek's agar (Czapek's culture solution [**5**] plus 2 per cent agar) containing different percentages of sucrose. To four lots of a standard nutrient solution,[2] sucrose was added in amounts of 0.0, 15.0, 30.0, and 60.0 grams, respectively, on the basis of each 1000 ml. of the medium. Petri-dish cultures of the fungus, after an incubation period of 13 days at 26° C., on the different media, showed very large differences in the percentages of beaked spores (table 2). On the first lot of media (without sucrose) the per-

TABLE 2

SPORE SIZE AND BEAK FORMATION IN ALTERNARIA STEMPHYLIOIDES, IN RELATION TO THE PERCENTAGE OF SUCROSE IN THE CULTURE MEDIUM *

Culture medium †		Spore size ‡				Beak formation—spores at			
Lot	Percentage of sucrose added	Length (μ) §		Width (μ)		Center of colony		Margin of colony	
		Range	Mean	Range	Mean	Number observed	Per cent beaked	Number observed	Per cent beaked
1	0.0	13–27	17.0	8–16	12.1	2,949	2.2	327	1.5
2	1.5	15–75	22.0	9–18	12.9	4,003	12.5	1,025	19.5
3¶	3.0	14–77	26.1	10–17	12.7	4,033	18.5	1,084	28.8
4	6.0	14–57	21.2	9–19	12.9	3,933	13.8	1,625	11.9

* Cultures incubated 13 days at 26° C.
† Unless otherwise specified, the culture medium used in these studies was the standard nutrient solution described in text footnote 2.
‡ Based on measurements of 100 spores from the margin of each colony.
§ Including beaks.
¶ Czapek's agar (Czapek's culture solution [**5**] plus 2 per cent agar).

centages of beaked spores were 2.2 near the central or oldest part of the colony, and 1.5 at the margin or youngest part of the colony, whereas on the third lot of media (3 per cent sucrose) the percentages were 18.5 and 28.8, respectively. The proportions of beaked spores from lots 2 and 4 were of intermediate value. Data for mean length of spores from the different media (table 2) paralleled those for beaked spores, partly because the beaks had

[2] The standard nutrient solution contained $MgSO_4 \cdot 7H_2O$, 0.5 gram; KH_2PO_4, 1.0 gram; KCl, 0.5 gram; $FeSO_4 \cdot 7H_2O$, 0.01 gram; $NaNO_3$, 2.0 grams; and distilled water, 1000 ml.

been included in the measurements. The number of transverse septa (table 3) was greater in spores cultured on media rich in sucrose than in spores from media containing little or no sucrose. The different media had only slight effect, however, on the width and on the longitudinal septation of the conidia. After 5 days at 26° C., average length of mycelial growth was 21, 12, 12, and 15 mm., respectively, for the four lots of media. Lot 1 (without

TABLE 3

SPORE SEPTATION * IN ALTERNARIA STEMPHYLIOIDES, IN RELATION TO THE PERCENTAGE OF SUCROSE IN THE STANDARD NUTRIENT SOLUTION †

Number of septa	Percentage of spores having							
	Transverse septa				Longitudinal septa			
	Lot 1 (sucrose 0.0 per cent)	Lot 2 (sucrose 1.5 per cent)	Lot 3 (sucrose 3.0 per cent)	Lot 4 (sucrose 6.0 per cent)	Lot 1 (sucrose 0.0 per cent)	Lot 2 (sucrose 1.5 per cent)	Lot 3 (sucrose 3.0 per cent)	Lot 4 (sucrose 6.0 per cent)
0	0.6	0.0	0.0	0.0	25.0	28.8	40.0	24.4
1	73.1	36.9	53.7	40.0	33.8	30.6	36.3	38.8
2	21.2	17.5	21.9	26.3	40.0	35.6	21.9	35.6
3	5.0	36.9	15.0	30.6	1.3	4.4	1.9	1.3
4		4.4	3.8	0.0		0.6		
5		3.8	1.9	1.9				
6		0.6	0.6	0.0				
7			0.6	0.0				
8			1.9	0.6				
9			0.6	0.0				
19				0.6				

* Each observation based on 160 spores from margin of colony. Cultures incubated 27 days at 26° C.

† From 0.0 to 6.0 per cent sucrose and 2.0 per cent agar were added to the standard nutrient solution described in text footnote 2.

sucrose) produced a sparse but rapid-growing colony which resembled a colony on water agar, previously mentioned (table 1). Slower-growing but very dense colonies were produced on the three lots that contained sucrose.

Alternaria stemphylioides was also cultured on sterile date fruit and on citrus fruit slices.[3] Only a few conidia developed on the dates, but there were many intercalary swellings in the mycelium. Development of the fungus on citrus fruit was reasonably similar to that on agar, and from 4 to 11 per cent of the conidia were beaked. No ascogenous stage was discovered.

[3] From fruits of Eureka lemon, Valencia and Washington Navel orange.

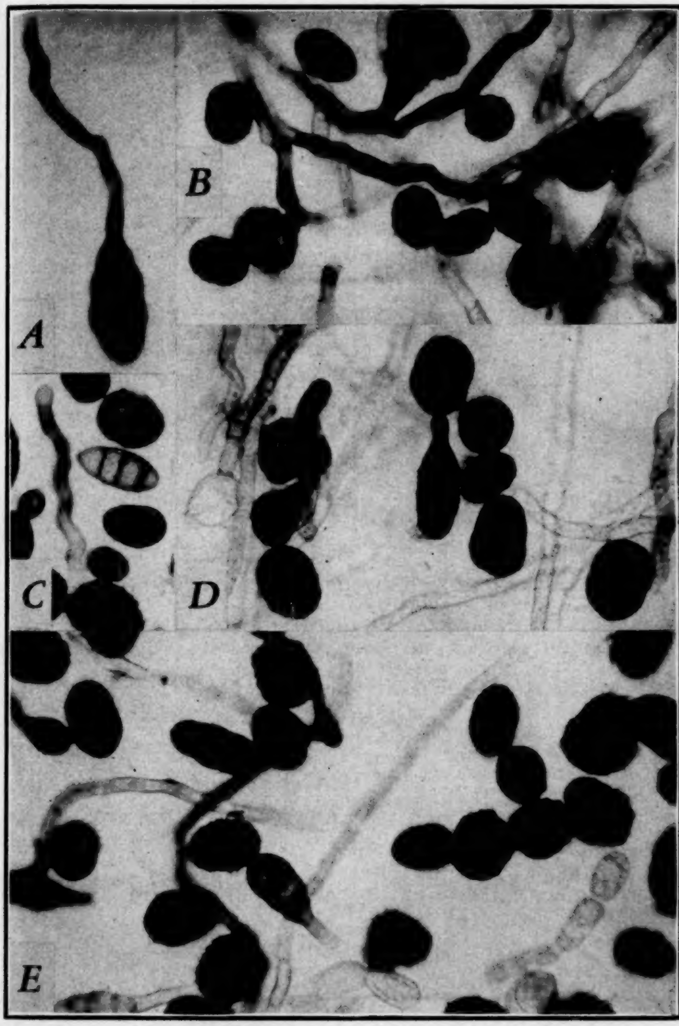

FIG. 2. *Alternaria stemphylioides* (× 593) on Czapek's agar, after 17 days at 26° C. *A*, conidium with long beak showing geniculations, septa, and spore scars; *B*, conidia, dark conidiophores, and hyaline mycelium; *C*, conidiophore and conidia; *D* and *E*, mycelium and conidia, some of which are beaked.

Culture B-402, strain *B*, has been selected as the type culture for *Alternaria stemphylioides*. Based on the measurement of 100 conidia from a culture incubated 13 days at 26° C., the distribution curves (FIG. 4) for length and width are fairly steep. The length curve, however, is "skew" in the upper range of values because of the beaked spores in the population. Analogous curves for culture B-718 (not shown) are similar to those for culture B-402. The two isolates are thought to be identical.

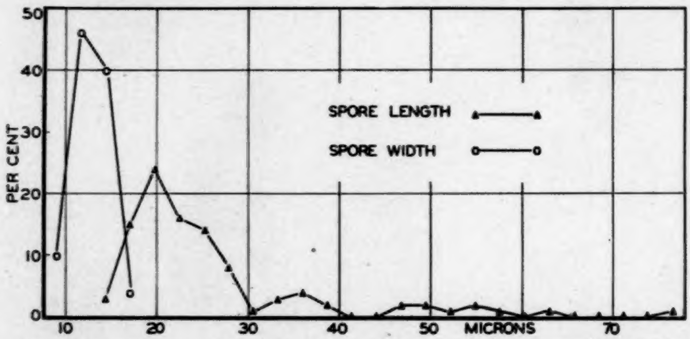

FIG. 3. Percentage distribution of spore sizes of *Alternaria stemphylioides*. The curves represent measurements of 100 spores from a colony on Czapek's agar, incubated 13 days at 26° C.

TAXONOMY

Because of its beaked spores and unswollen conidiophores, the fungus described in the present paper is now considered to be a species of *Alternaria* Nees. When first observed, however, it was tentatively referred to the genus *Stemphylium* Wallroth, and to that particular group of species termed *Pseudostemphylium* by Wiltshire (**8**).

Similarities have been noticed between *Alternaria stemphylioides* and several other fungi. *Stemphylium botryosum* sensu Oudemans, as illustrated and described by Wiltshire (**8**), is similar except that "sometimes the conidiophore, instead of growing out immediately below the conidium does so lower down so that it is branched." Wiltshire (**8**) considers *S. botryosum* of Oudemans to be identical with *S. lanuginosum* Harz. Species allied to *S. lanuginosum* comprise the group *Pseudostemphylium*.

The published photographs of *Stemphylium dendriticum* De Sousa da Camara (2) are similar to *Alternaria stemphylioides* as it appears on corn-meal agar, but since the spores of *S. dendriticum* are described as acro-pleurogenous and without beaks, the two fungi are apparently distinct. *S. congestum* Newton (**4**) also shows similarity but, in the absence of beaked conidia, it may properly belong with the group *Pseudostemphylium.*

Perhaps the closest similarity thus far noted is that between *Alternaria stemphylioides* and a *Stemphylium* saltant of an *Alternaria* described by Wiltshire (**6**). He found that, when cultured on Richards' agar, an *Alternaria* isolated from grapes repeatedly produced saltating sectors of a *Stemphylium*-like fungus. This saltant is described in part as olivaceous black to deep olive in culture, with oval, muriform, sometimes pointed, coarsely warted spores having 0 to 5 (mostly 3) cross septa. According to Wiltshire (**6**), "conidia of the *Alternaria* type occasionally occur," and the conidia, which measure $11–38 \times 9–21\ \mu$, are sometimes "so opaque that the cross walls cannot be discerned. . . . Chains of two or three conidia are not uncommon, but the maximum number observed in a chain did not exceed four. . . . Sometimes the distal end of the spore is prolonged to form itself a short conidiophore, which again bears a small head of spores." Hyphae immersed in the agar produce nearly spherical conidia with characteristic gas bubbles at the center.

This description, except perhaps for the conidia on immersed hyphae, fits very well the description of *Alternaria stemphylioides*. It appears, however, that the modern concept of the genus *Stemphylium* changed somewhat between 1929, when Wiltshire (**6**) described this saltant, and 1938, when he (**8**) outlined the original and modern conceptions of this genus. In the later publication, Wiltshire (**8**) states that the characters distinguishing the genus *Stemphylium* Wallroth "are (1) that the conidiophores are swollen at the apex which bears a single terminal spore (though this may be forced into a lateral position by the continued growth of the conidiophore); (2) that the growth of the conidiophore is continued through the terminal scar, the successive swellings recognizable in an old conidiophore marking the places where conidia have been borne; and (3) that the spore shape is oval or sub-

angular, frequently constricted at the major, median transverse wall and *never beaked*."[4] Even after retaining within the genus the species allied to *S. lanuginosum* Harz (*Pseudostemphylium* group), it would not seem logical to include a fungus like *Alternaria stemphylioides*, in which, under certain conditions, approximately one fourth of the conidia are beaked.

On the other hand, *Alternaria stemphylioides* appears to fit quite properly in the genus *Alternaria* Nees, as characterized by Wiltshire (**7**). The conidia of this species are not "typically obclavate" because of the relatively low percentage of beaked spores; but oval, nonbeaked spores are common in *Alternaria*, sometimes occuring in relatively large numbers (**1**).

As to taxonomy within the genus, *Alternaria stemphylioides* seems to be more or less in a class by itself. The relative absence of short beaks separates it from *A. Citri* and related forms (**1**), although the spore dimensions are similar. The habit of forming botryose clusters of spores, the absence of long spore chains, and the predominance of oval, nonbeaked spores, tend to place this species in an intermediate position between the *A. Citri* group of *Alternaria* and the *Pseudostemphylium* group of *Stemphylium*; hence the name, *A. stemphylioides*.

SUMMARY

A new species of *Alternaria*, described as *A. stemphylioides*, has been isolated from fruit of the date palm, *Phoenix dactylifera* L., in the Coachella Valley, California. The conidia of this fungus are borne acrogenously but, because of the tendency toward unlimited apical elongation of the conidiophore, they are mostly pushed into lateral positions. Some of the primary conidia are beaked and develop secondary conidia. Although chains of 3 spores are found occasionally, the beak of the primary conidium usually elongates at the apex slightly to one side of the point of attachment, pushes the secondary conidium into a lateral position, and forms another spore at the apex. By repeating this process several times, the beak of the primary conidium becomes a secondary conidiophore.

[4] Italicized by the present writer.

The percentages of beaked spores varied considerably when the fungus was cultured on different media (corn-meal agar, glucose potato agar, Czapek's agar, vegetable agar, and water agar). Variation in the proportion of sucrose in Czapek's agar caused the production of beaked spores to vary from 1.5 per cent in cultures with no sucrose to 28.8 per cent in cultures containing 3 per cent sucrose. The size and septation of the spores were also affected by these variations in sugar content.

Although *Alternaria stemphylioides* shows marked similarity to certain species of *Stemphylium*, especially those of the *Pseudostemphylium* group, it is referred to the genus *Alternaria* because of its beaked spores and unswollen conidiophores. From the taxonomic standpoint, this new species seems to occupy an intermediate position between the *A. Citri* group of *Alternaria* and the *Pseudostemphylium* group of *Stemphylium*.

ACKNOWLEDGMENT

Appreciation is expressed to Miss Edith K. Cash for the preparation of the Latin description.

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NOTES AND BRIEF ARTICLES

The Mycetozoa of North America

In recent years the most active student and collector of Myxomycetes in North America has been Mr. Robert Hagelstein, whose contributions to our knowledge of these forms have been appearing in Mycologia and elsewhere for many years. It is fortunate for all students of the group that he has been able to sum up the results of his studies in a handsome volume of over 300 pages, illustrated with sixteen plates, four of which are in color. The treatment is restricted to species known to occur in North America, but since, of the 318 species which the author regards as valid, 285 are known to occur in that continent, a very representative assemblage is included. The work is based very largely on the collections in the New York Botanical Garden, interpreted in the light of the author's unequalled field experience. The colored plates are excellent; the half-tones in most cases show detail or habit fairly well, but some are distinctly disappointing.

The classification adopted is, in general, that of Lister which, however unsatisfactory, is no more so than that stemming from Macbride, and the treatment throughout is reminiscent of the Lister monograph. The keys, for the most part, are more usable than any which have yet appeared, although in some of the larger genera the number of choices to be considered is unduly large, as in those of Lister, on which they appear to be modelled.

As the author admits in his introduction, much remains to be learned about the slime molds, and there is bound to be great difference of opinion as to species limitations until more is known about the extent of variation possible when plasmodia of the same species fruit under different environmental conditions. The present reviewer would recognize a number of species reduced by Hegelstein to varietal rank or to synonymy and he would take strong exception to the wide range in spore size allowed for many species. The substitution of the name *Arcyria vitellina* for the established name *A. versicolor,* said to be in accordance with

present rules, is directly contrary to the provision of Art. 56, and the use of *Cribraria aurantia* instead of *C. vulgaris,* if these names are regarded as referring to the same species, is subject to the same criticism. Most of the changes appear, however, to be defensible, and it is to be expected that experience will justify many of them. Obviously, great care has been used to make the citations correct and the bibliography, prepared with the aid of Dr. Barnhart, is distinctly superior to any published in earlier works.

The book should be of very great service to students and it is to be hoped that it will stimulate interest in and study of a fascinating group or organisms. It is published by the author, 165 Cleveland Avenue, Mineola, N. Y. and sells for $6.00—G. W. MARTIN.

"The Mycetozoa of North America" by Robert Hagelstein is the latest contribution to our knowledge of this group of interesting organisms. For over 200 years they have found a more or less definite place in botanical literature. The first volume devoted to North American species was published by Macbride in 1899.

The author of the present volume has had for his studies access to the large collections of the New York Botanical Garden which include much type and authentic material. For twenty years he has made extensive field studies and is as familiar with the habitat and distribution of these forms in nature as he is with herbarium specimens. Several times it has been the privilege of your reviewer to share the enthusiasm of the author as he was making observations and collections both in the States and in the West Indies. In the introduction the development of the plasmodia and the production of the fruiting bodies is discussed and some excellent suggestions for their care and preservation are given. The point that there are opportunities for research in the morphology, physiology, and taxonomy of the group is well taken.

In the arrangement of the species within a genus especial attention has been given to a sequence based on affinities. The attempt to make a natural sequence is most laudable even though often difficult. The citations and bibliography have been carefully

prepared. Complete lists of synonyms are not given. Since they would not have added much to the length of the presentation, but would have added desirable information in some cases, their omission seems unwarranted. The book describes 285 species from North America. It is stated that the entire number of species regarded as valid in the world is 318. No theories are offered to explain how practically 90 per cent all known species occur in North America. While many species are almost world-wide in their distribution, others are limited to comparatively small areas. It seems likely that those in many other parts of the world are less well known than those in North America.

The neatly bound volume has 306 pages including glossary, bibliography, index, and explanation of plates. There are 16 full-page plates each with several figures. The illustrations are chiefly photographs of aethalia or sporangia. The book is published by the author and comes from the Lancaster Press.—FRANK D. KERN.

ON SOME BASIDIOMYCETES NEW FOR THE UNITED STATES

AGARICUS BAMBUSIGENUS Berk. & Curt. This species has been collected at several localities in Florida. It was hitherto known only from Cuba. Murrill redescribed it under the name *Agaricus Rhoadsii* Murr. The types of both these species have been compared.

Copelandia Westii (Murr.) Sing. comb. nov. (*Panaeolus Westii* Murr. 1942; *Copelandia papilionacea* Bres. non Fries). As the examination of the types shows, *Panaeolus Westii,* recently described from Alachua Co., Fla., has the same characteristic colored cystidia as the species incorrectly identified with *Panaeolus papilionaceus* by Bresadola, and hitherto known from the Philippine Islands only. The genus *Copelandia* is new for the United States and for this Hemisphere in general.

GALERINA NANA (Petri) Kuhner. This species has previously been known only from Europe. It was described as *Naucoria nana* from Italy, later misdetermined as an *Inocybe* by Velenovsky in Czechoslovakia, and eventually recollected and correctly transferred to *Galerina* by Kuhner in France. It also occurs in Leningrad (coll. & det. Singer). I found it in May 1944 in my cellar

in Arlington Mass., growing on fence poles that had been stored there for the winter. *G. nana* differs from all species of *Galerina* by its cystidia which recall these of *Inocybe*.

LACHNOCLADIUM BRASILIENSE Lév. This species is widely different from all other so-called Lachnocladiums in having the hyphae of the twigs transformed into branching, colored, stiff, bristle-like bodies. Most of the species of *Lachnocladium* in the present conception are tall Pterulas. The name *Lachnocladium* should be reserved for fungi of the type of *L. brasiliense,* and the latter be made the type of the genus, *L. brasiliense* is frequent in Southern Florida where it forms enormous cespitose fruiting masses. It has not been recorded in continental North America before.

LEUCOPAXILLUS GRACILLIMUS Sing. & Smith. A larger form (pileus 50–80 mm., stipe 40–50 × 5–7 mm.) of this Brazilian species has been found by Rapp at Hunters Station, Alachua Co., Fla., and was given a herbarium name by W. A. Murrill, according to whom the fresh pileus is "latericious, or with a small bay disk," the lamellae pure white, the stipe milk white, the taste becoming somewhat astringent, scarcely bitter, the odor slightly farinaceous." I found the dried pileus Pl. 6–9 E to 10 C (Maerz & Paul), or "vinaceous fawn," or "Sorghum brown" with some "vinaceous brown," the disk sometimes "dark vinaceous brown," the lamellae exceedingly close (3 or more to a mm.), the spores as in the type.

PTERULA CAPILLARIS (Lév.) Sacc. Collected in the Florida Coastal Hammock area, and compared with the type from Java, and specimens from Ecuador and the Philippine Islands, this evidently pantropical species is a new member of the North American Flora.

PTERULA PALLESCENS Bres. Originally described from Africa, this species is represented (under the apparently wrong name *Calocera divaricata* Berk.) in Patouillard's Herbarium (from San Domingo) and has recently been collected by the writer near Gainesville in a mesophytic hammock. When fresh, it is rather soft, white, and has a peculiar odor of iodoform. The warty-dentate spores are unusual in the genus *Pterula*. This species will sooner or later be separated from *Pterula*.

SCHIZOPHYLLUM UMBRINUM Berk. This species, kindly determined by D. H. Linder, and formerly reported from Cuba and Nicaragua, has been collected by the writer in South Florida on a trunk of *Persea americana.*

THELEPHORA MAGNISPORA Burt. Described from Jamaica, this rare tropical species has been collected by the writer in South Florida (Royal Palm State Park), the first collection in continental North America. The spores with their 2 μ long spines are unmistakable.

TROGIA CANTHARELLOIDES (Mont.) Pat., and its synonyms *Lentinus scyphoides* Pat. and *L. subscyphoides* Murr. have never been been indicated from continental North America, nor has any species of *Trogia* ever been found in the United States. What sometimes incorrectly is called *Trogia,* is a meruliaceous species, the common Northern *Plicatura crispa* while the real Trogias are confined to the tropics. When collecting in Southern Florida, I found *Trogia cantharelloides* to be one of the commonest wood-inhabiting fungi, sometimes partly beautifully violet.—R. SINGER.